AD-A105 095 ANDERSON ENGINEERING INC SPRINGFIELD MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. BLACKBERRY HAY FARM DAM (MO 20196)--ETC(U)
SEP 79 J M HEALY, G WERTEPNY, S L BRADY DACW-43-79-C-0070
UNCLASSIFIED NL

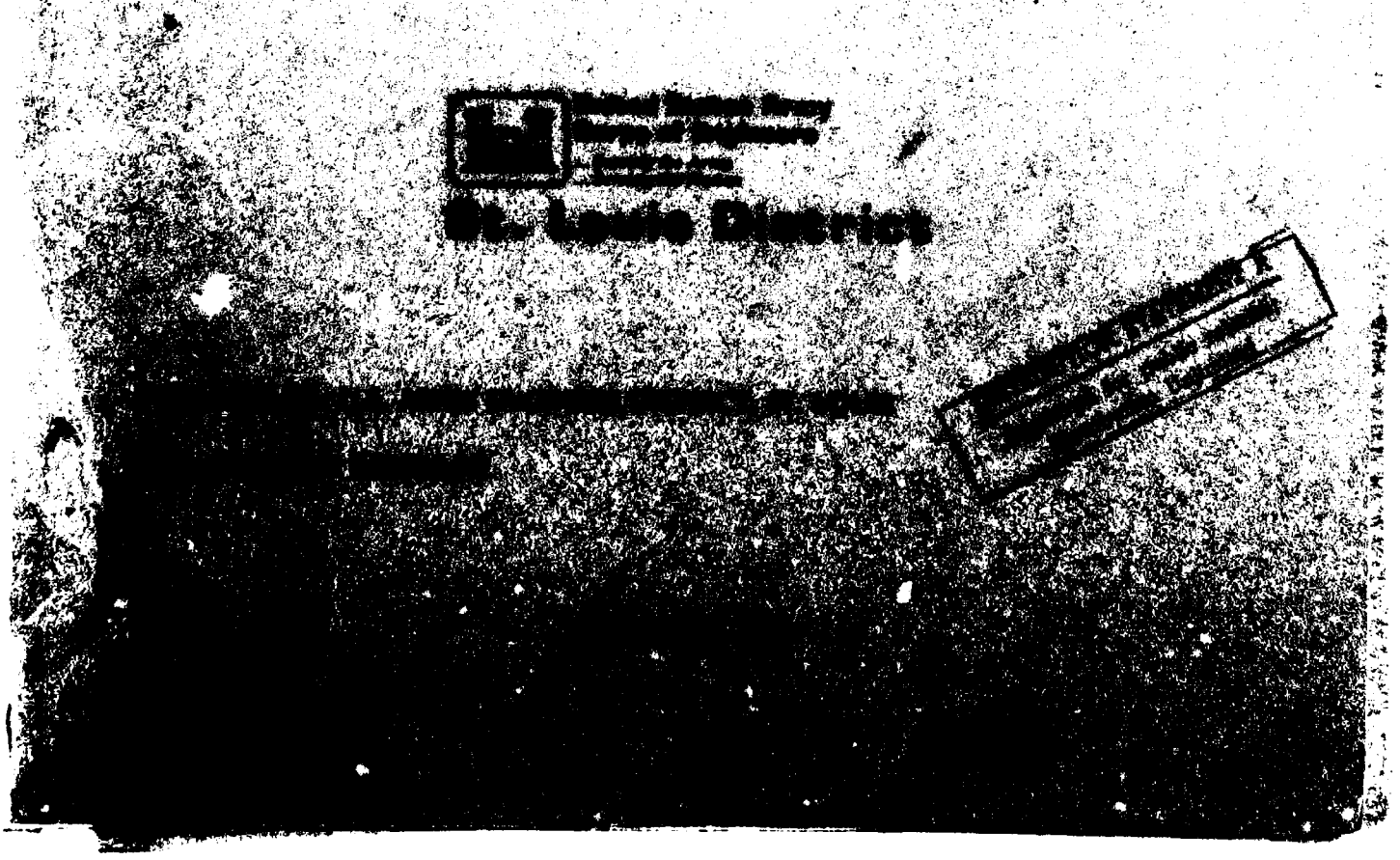
END
DATE FILMED
10-81
DTIC

LEVEL II

VERDIGRIS-NEOSHO BASIN

BLACKBERRY HAY FARM DAM
JASPER COUNTY, MISSOURI
MO 29156

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM



UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE	READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A105 095	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Blackberry Hay Farm Dam (MO 20196) Jasper County, Missouri (9)	5. TYPE OF REPORT & PERIOD COVERED Final Report
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Anderson Engineering, Inc.	8. CONTRACT OR GRANT NUMBER(s) (15) DACW43-79-C-0070
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (12)
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101 (11)	12. REPORT DATE September 1979
	13. NUMBER OF PAGES Approximately 50
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (10) John M. /Healy Gene /Wertepny Steven L. /Brady John /Renner Tom /Beckley	15. SECURITY CLASS. (of this report) UNCLASSIFIED
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

(6)

18. SUPPLEMENTARY NOTES

National Dam Safety Program. Blackberry Hay Farm Dam (MO 20196), Verdigris - Neosho Basin, Jasper County, Missouri. Phase I Inspection Report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED 42554 x11
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Blackberry Hay Farm Dam, MO 20196

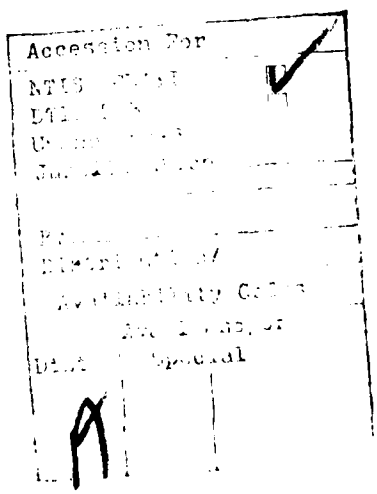
This report presents the results of field inspection and evaluation of the Blackberry Hay Farm Dam. It was prepared under the National Program of Inspection of Non-Federal Dams.

SUBMITTED BY: SIGNED
Chief, Engineering Division

20 SEP 1979
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

20 SEP 1979
Date



BLACKBERRY HAY FARM DAM

JASPER COUNTY, MISSOURI

MISSOURI INVENTORY NO. 20196

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Prepared by

Anderson Engineering, Inc. Springfield, Missouri
Hanson Engineers, Inc., Springfield, Illinois

Under Direction of

St. Louis District, Corps of Engineers

For

Governor of Missouri

September, 1979

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Blackberry Hay Farm Dam
State Located:	Missouri
County Located:	Jasper County
Stream:	Pond Creek
Date of Inspection:	20 June 1979

Blackberry Hay Farm Dam was inspected by an interdisciplinary team of engineers from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and visual inspection, in order to determine if the dam poses hazards to human life or property.

The guidelines used in the assessment were furnished by the Department of the Army, Office of the Chief of Engineers, and they have been developed with the help of several Federal and State agencies, professional engineering organizations, and private engineers. Based on these guidelines, the St. Louis District, Corps of Engineers has determined that this dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur if the dam fails. The estimated damage zone extends approximately 3.5 miles downstream of the dam. Located within this zone are 5 dwellings. The dam is in the intermediate size classification since the maximum storage capacity is greater than 1000 acre-feet but less than 50,000 acre-feet.

Our inspection and evaluation indicates that the combined spillways do not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. The combined spillways will pass 60 percent of the Probable Maximum Flood without overtopping. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The guidelines require that a dam of

intermediate size with a high downstream hazard potential pass the PMF. The 100-year frequency flood will not overtop the dam. The 100-year flood is one that has a 1 percent chance of being exceeded in any given year.

The embankment appeared to be generally in fair condition. Deficiencies visually observed by the inspection team were: (1) Serious wave erosion on the front face of the embankment; (2) Surface erosion on crest and downstream face in center portion of dam; (3) Some trees and brush on downstream face; (4) Standing water at toe of dam near center and in primary spillway channel; (5) seepage on downstream face along west finger of embankment; (6) heavy grass and brush in primary spillway channel; and (7) lack of protection of downstream toe from emergency spillway releases.

Another deficiency was the lack of seepage and stability analysis records.

It is recommended that the owners take the necessary action in the near future to correct the deficiencies reported herein. A detailed discussion of these deficiencies is included in the following report.

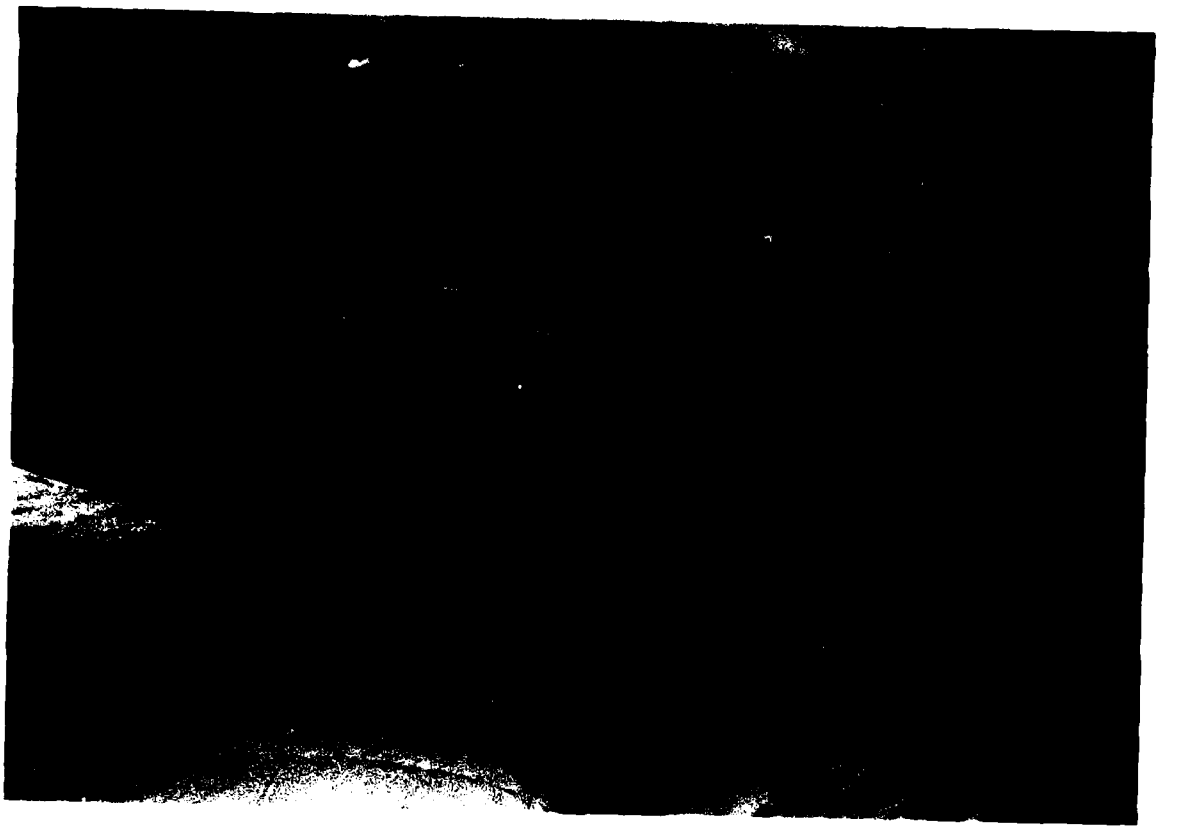
John M. Healy, P.E.
Hanson Engineers, Inc.

Gene Wertepny, P.E.
Hanson Engineers, Inc.

Steven L. Brady, P.E.
Anderson Engineering, Inc.

John Renner, EIT
Anderson Engineering, Inc.

Tom Beckley, P.E.
Anderson Engineering, Inc.



AERIAL VIEW OF LAKE AND DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

BLACKBERRY HAY FARM DAM ID No. 20196

TABLE OF CONTENTS

APPENDICES

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL:

A. Authority:

The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection be made of Blackberry Hay Farm Dam in Jasper County, Missouri.

B. Purpose of Inspection:

The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon available data and a visual inspection in order to determine if the dam poses hazards to human life or property.

C. Evaluation Criteria:

Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief Engineers, "Recommended Guidelines for Safety Inspection of Dams, Appendix D." These guidelines were developed with the help of several federal agencies and many state agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT:

A. Description of Dam and Appurtenances:

Blackberry Hay Farm Dam is an earth fill structure approximately 20 ft. high and 2900 ft. long at the crest. The appurtenant works consist of earth lined overflow spillways in the north and west abutments. Two 8 inch diameter steel pipes are provided at Stas. 15+00 and 17+00 to drain the lake. Sheet 3 of Appendix A shows a plan, profile and typical section of the embankment.

B. Location:

The dam is located in the northwest corner of Jasper County, Missouri on Pond Creek. The dam and lake are within

the Pittsburg, Kansas-Missouri 15 minute quadrangle sheet (Section 30, T30N, R33W - latitude 37° 19.26'; longitude 94° 35.84'). Sheet 2 of Appendix A shows the general vicinity.

C. Size Classification:

With an embankment height of 20 ft. and a maximum storage capacity of approximately 1400 acre-ft., the dam is in the intermediate size category.

D. Hazard Classification:

The St. Louis District, Corps of Engineers has classified this dam as a high hazard dam. The estimated damage zone extends approximately 3.5 miles downstream of the dam. Located within this zone are 5 dwellings.

E. Ownership:

The dam is owned by William F. Lethone, Trustee. The owner's address is P. O. Box 1296, Joplin, Missouri 64801.

F. Purpose of the Dam:

The dam was constructed primarily for duck hunting, however it is now used primarily for irrigation purposes.

G. Design and Construction History:

The dam was built in the 1940's. The dam was expanded in the middle 1960's which resulted in raising the water level of the lake approximately 4 feet. In 1977 restoration work was completed on the embankment and the primary spillway size was increased. The information was obtained from Mr. Edward H. Landreth, P. O. Box 123, Joplin, Mo., 64801, who is also part owner of the farm. Mr. Landreth also indicated that the material for the dam was taken from the lake area. Mr. Red Fox of Parsons, Kansas, was the contractor and the fill was placed with scrappers and sheepsfoot rollers. No riprap was used on the upstream face. No plans or design information is available. A topographic survey of the dam and lake area was performed by Stewart Engineering Co., Inc., of Joplin, Mo., in 1965. A copy of the topo is included as Sheet 4 of Appendix A.

H. Normal Operational Procedures:

All flows are passed by an earth lined primary spillway

in the north abutment and an earth lined emergency spillway in the west abutment which would come into operation for major storms. Mr. Edward H. Landreth indicated that the maximum flow over the primary spillway has been approximately 6 inches.

1.3 PERTINENT DATA:

Pertinent data about the dam, appurtenant works, and reservoir are presented in the following paragraphs. Sheet 3 of Appendix A presents a plan, profile and typical section of the embankment.

A. Drainage Area:

The drainage area for this dam, as obtained from the U.S.G.S. quad sheet, is approximately 1680 acres.

B. Discharge at Dam Site:

(1) All discharge at the dam site is through uncontrolled spillways.

(2) Estimated Total Spillway Capacity at Maximum Pool (Top of Dam - El. 111.5): 7235 cfs

(3) Estimated Capacity of Primary Spillway: 5052 cfs

(4) Estimated Experienced Maximum Flood at Dam Site: 140 cfs

(5) Diversion Tunnel Low Pool Outlet at Pool Elevation: Not Applicable

(6) Diversion Tunnel Outlet at Pool Elevation: Not Applicable

(7) Gated Spillway Capacity at Pool Elevation: Not Applicable

(8) Gated Spillway Capacity at Maximum Pool Elevation: Not Applicable

C. Elevations:

(1) Top of Dam: 111.5 Feet (Ave.); 112.6 Feet (High Point)

(2) Principal Spillway Crest: 107.0 Feet

(3) Emergency Spillway Crest: 109.0 Feet

(4) Principal Outlet Pipe Invert: None

(5) Streambed at Centerline of Dam: 92.5 Feet

(6) Pool on Date of Inspection: 106.72 Feet

(7) Maximum Tailwater: Unknown

(8) Upstream Portal Invert Diversion Tunnel: Not Applicable

(9) Downstream Portal Invert Diversion Tunnel: Not Applicable

D. Reservoir Lengths:

(1) At Top of Dam: 1.1 Miles

(2) At Principal Spillway Crest: 1.0 Miles

(3) At Emergency Spillway Crest: 1.05 Miles

E. Storage Capacities:

(1) At Principal Spillway Crest: 640 Acre-Feet

(2) At Top of Dam: 1405 Acre-Feet

(3) At Emergency Spillway Crest: 980 Acre-Feet

F. Reservoir Surface Areas:

(1) At Principal Spillway Crest: 160 Acres

(2) At Top of Dam: 180 Acres

(3) At Emergency Spillway Crest: 169 Acres

G. Dam:

(1) Type: Earth Fill

(2) Length at Crest: 2900 Feet

(3) Height: 20 Feet

(4) Top Width: Varies from 8 Feet to 16 Feet

(5) Side Slopes: Upstream 0.98H:IV to 3.9H:IV; Downstream 3H:IV

(6) Zoning: None (Homogeneous)

(7) Impervious Core: None

(8) Cutoff: Unknown

(9) Grout Curtain: None

H. Diversion and Regulating Tunnel:

(1) Type: None

(2) Length: Not Applicable

(3) Closure: Not Applicable

(4) Access: Not Applicable

(5) Regulating Facilities: Not Applicable

I. Spillway:

I.1 Principal Spillway:

(1) Location: North Abutment

(2) Type: Grass covered channel (trapezoidal)

I.2 Emergency Spillway:

(1) Location: West Abutment

(2) Type: Grass covered channel (trapezoidal)

J. Regulating Outlets:

Two 8 inch diameter steel pipes are located under the dam for draining the lake. One pipe is located at Sta. 15+00 and one is located at Sta. 17+00. The valves for both pipes are gate valves and they are located at the downstream toe of the dam. The west valve (Sta. 17+00) was leaking slightly and the east valve was submerged. A 12 inch irrigation pipe is located near the emergency spillway at the west end of the dam. This pipe is used when irrigation water is needed. An auxillary pump is brought to this area and water is pumped from the lake into this pipe.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN:

No engineering data exists for this dam. No construction inspection records or documented maintenance and operation data exist to our knowledge.

A. Surveys:

A topographic survey was performed on the lake and dam area in 1965 by Stewart Engineering Co., Inc., of Joplin, Mo. A copy of this survey is included as Sheet 4 of Appendix A. The top of the 8 inch drain pipe outlet at Sta. 17+00 was used as datum for our site survey (Elev. 100.00).

B. Geology and Subsurface Materials:

The site is located in the Western Plains geologic region of Missouri. The Western Plains region is characterized topographically by being level to gently undulating with wide imperceptibly rising floodplains. The sedimentary rock layers exposed in the Ozarks region dip downward away from the Ozarks region and the higher and younger sedimentary deposits become the surface ledges in southwest Missouri. Generally the soils in the Western Plains region are residual from limestone, shale and sandstone with some loess cover in some areas. Acid micaceous Pennsylvanian shales and cherty Mississippian limestone formed the parent material for the soils found in the area of the Blackberry Hay Farm Dam.

Soils in the area of the dam appear to be primarily silts, clayey silts and silty clays with some chert fragments. The soils are of the Parsons and Cherokee soil series. The loessial thickness map (Sheet 2 of Appendix B) indicates that some areas of this region may have between 2.5 and 5.0 feet of loess cover.

The "Geologic Map of Missouri" indicates that the nearest known fault runs in a northeast-southwesterly direction approximately 20 miles south of the dam site. The Missouri Geological Survey has indicated that the faults in this area are generally considered to be inactive and have been for several hundred million years. The publication "Caves of Missouri" indicates there are two caves in Jasper County, however they are locationed several miles south of the dam.

C. Foundation and Embankment Design:

No design computations are available. The source of material for the embankment was from the lake area. Our site inspection indicates that these materials are primarily residual silts, cherty silts and silty clays. No internal drainage features are known to exist nor did these appear to be any particular zoning of the embankment. No construction inspection records are available.

D. Hydrology and Hydraulics:

No hydrologic or hydraulic design data were obtained. Our analyses of the PMF are presented in Appendix C. These analyses were based on our field survey and observations, and estimates of areas and volumes from the U.S.G.S. quad sheet. It was concluded that the structure will pass 60 percent of the Probable Maximum Flood without overtopping. The 100-year frequency flood will not overtop the dam.

E. Structure:

The only appurtenant structures are the two 8 inch diameter steel drawdown pipes with the gate valves at the downstream end and a 12 inch irrigation pipe at the west end of the dam. Mr. Edward H. Landreth indicated that the west drawdown pipe (Sta. 17+00) was installed when the embankment was enlarged in the middle 1960's.

2.2 CONSTRUCTION:

No construction inspection data have been obtained.

2.3 OPERATION:

There are no operating records to our knowledge. Mr. Edward H. Landreth said that erosion damage to the embankment was repaired and the primary spillway size was increased in 1977. The dam is apparently cleared every few years however there were a few areas of tree and brush on the embankment.

2.4 EVALUATION:

A. Availability:

The engineering data available are listed in Section 2.1.

B. Adequacy:

The engineering data available were inadequate to make a detailed assessment of the design, construction, and operation. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

C. Validity:

No valid engineering data on the design or construction of the embankment are available to our knowledge.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS:

A. General:

The field inspection was made on 20 June 1979. The inspection team consisted of personnel from Anderson Engineering, Inc. of Springfield, Missouri and Hanson Engineers, Inc. of Springfield, Illinois. The team members were:

John M. Healy-Hanson Engineers, Inc. (Geotechnical Engineer)
Gene Wertepny - Hanson Engineers, Inc. (Hydraulics Engineer)
Steven L. Brady - Anderson Engineering, Inc. (Civil Engineer)
Tom Beckley - Anderson Engineering, Inc. (Civil Engineer)
John Renner - Anderson Engineering, Inc. (Civil Engineer)

B. Dam:

The embankment appears to have been built on a curve which is concave downstream. The crest of the dam has variations of up to 3 feet in height. No evidence was seen of settlement, sinkholes, slides, or other vertical movement of the embankment. The west and north fingers of the dam are covered with grass. The middle of the embankment has very little grass cover and has seriously eroded. This appears to be the main area of restoration that took place in 1977 (between Stas. 12+50 and 18+00). Some surface cracking has occurred on the crest although this cracking does not appear to be serious. The width of the cracks vary up to 3/8 inch wide and 3 feet long. The cracks appear to be caused by shrinkage of the surface layer of soil. Shallow auger probes into the embankment indicated the embankment to consist of silty soils on the west fingers of the embankment with clayey silts and silty clays with chert fragments on the center portion and north finger. The front face of the embankment has suffered serious wave erosion. The north finger of the embankment had the most erosion (see photo No.7). No riprap was apparently used on the front face of the embankment. There were a few areas of trees and brush. These primarily were on the downstream face near the center of the dam. No animal burrows were noted, although some could exist in the areas of heavy brush, which could not be detected.

A seepage area was noted along the downstream face near the toe near Sta. 18+00. The seepage area was approximately 20 feet wide. A slow oozing of water was occurring over the

general area. The quantity of water flowing from the seepage area was small and not able to be measured. The water was clear and no boils were noted (see photo No.24). Considerable water was ponded at the toe and on the floodplain below the center of the dam. Also a wet area existed in the primary spillway channel. These areas appear to be due to poor drainage. It is also possible that some leakage could be occurring under the dam in the area of the old streambed especially in the case of the ponded water at the toe of the dam.

No instrumentation (monuments, piezometers, etc.) was observed.

C. Appurtenant Structures:

C.1 Primary Spillway:

The primary spillway consists of a grass lined channel existing at the north abutment and running along the north finger or east side of the embankment. The approach to the spillway is wide and open. The discharge channel is flat and wide with heavy grass and some brush. An earth berm beginning at Sta. 7+00 extends southward from the embankment to keep spillway discharges away from the embankment.

C.2 Emergency Spillway and Outlet:

The emergency spillway is in the west abutment. The spillway is wide and flat. The approach to the spillway is open. Releases from the emergency spillway will run along the toe of the west embankment possibly causing erosion to occur.

D. Reservoir Areas:

The slopes adjacent to the lake are generally nearly level. Some slopes may approach 3%. The watershed is grass and crop land. The water was brown colored on the date of inspection. Some siltation has probably occurred in the lake.

E. Downstream Channels:

Some trees and brush exist in the outlet channel as the channel approaches the road that borders the dam on the south.

3.2 EVALUATION:

Severe erosional damage exists on the upsteam face of the dam. Erosion protection such as riprap will be necessary. The erosional damage to the crest and downstream face between Stas. 12+50 and 18+00 is serious and will continue to worsen if not corrected. Trees and brush on the dam and in the spillway discharge channels should be cleared on an annual basis. All suspected areas of seepage should be investigated by an engineer experienced in the design and construction of dams. The discharge channel of the emergency spillway is such that releases from the spillway could erode the downstream toe of the dam. All of the above are deficiencies which should be corrected.

Because the valves of the two lake drains are located on the downstream side of the dam, the full head of water impounded by the dam is acting entirely through the dam. The area around the lake drain outlets should be periodically inspected for seepage which might indicate a leak or rupture of the drain pipes which could eventually initiate a piping failure through the embankment.

Photographs of the dam, appurtenant structures, and the reservoir are presented in Appendix D.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES:

There are no controlled outlet works for this dam except for the two 8 inch diameter drawdown pipes, which are apparently used very infrequently. The spillways are uncontrolled, so that the pool is normally controlled by rainfall, runoff, evaporation and use of the water for irrigation.

4.2 MAINTENANCE OF DAM:

Erosion on the dam was repaired in 1977. The dam is apparently cleared every few years however there were a few areas of trees and brush on the embankment.

4.3 MAINTENANCE OF OPERATING FACILITIES:

The drawdown facilities appear to be generally in good condition. The gate valve on the pipe at Sta. 17+00 was leaking. It is not known whether these facilities are regularly maintained.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT:

The inspection team is unaware of any existing warning system for this dam.

4.5 EVALUATION:

Vegetation on the dam should be cut annually. Erosional areas should be corrected and maintained. The area around the drain outlets should be inspected for seepage which might indicate a leak or rupture of the drain pipes.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES:

A. & B. Design and Experience Data:

The hydraulic and hydrologic analyses were based on: (1) a field check of spillway dimensions and embankment elevations; and (2) an estimate of the pool and drainage areas from the U.S.G.S. quad sheet. No previous hydraulic or hydrologic studies were obtained. Our hydrologic and hydraulic analyses using U.S. Army Corps of Engineers guidelines appear in Appendix C.

C. Visual Observations:

The outlet channel for the primary spillway has considerable heavy grass and brush. Also considerable trees and brush exist in the downstream channel near the road along the south side of the dam.

The emergency spillway channel is beside the downstream toe of the west finger of the embankment. Some erosion of the embankment could occur if the spillway is used.

There is no knowledge of the dam ever being overtopped.

D. Overtopping Potential:

Based on the hydrologic and hydraulic analysis presented in Appendix C, the spillways will pass 60 percent of the Probable Maximum Flood. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief Engineers, require that this structure (intermediate size with high downstream potential pass the PMF, without overtopping.

The routing of the PMF through the spillways and dam indicate that the dam will be overtopped by 0.80 ft. at elevation 112.30. The duration of the overtopping will be 1.92 hours and the maximum outflow will be 16,374 cfs. The maximum discharge capacity of the combined spillways is 7235 cfs. Analysis of the data indicates that the 100-year frequency flood will not overtop the dam. Overtopping of this

earthen embankment could cause very rapid and disastrous erosion and could possibly lead to failure of the structure.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY:

A. Visual Observations:

Visual observations which could adversely affect the structural stability of this dam are discussed in Sections 3.1B and 3.2.

B. Design and Construction Data:

No design and construction data for the foundation and embankment were available. Our site inspection indicates that the materials composing the dam are primarily silts, silty clays and clayey silts mixed with rock. It is not known whether internal drainage features were incorporated. No construction inspection records are available. Seepage and stability analyses comparable to the requirements of the guidelines were not available, which constitutes a deficiency which should be rectified.

C. Operating Records:

No operating records have been obtained.

D. Post-Construction Changes:

In the middle 1960's the embankment was enlarged such that it raised the water level in the lake approximately 4 feet. The soil for the work came from an area of the lake that is now under water.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in stability analyses for this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT:

This Phase I inspection and evaluation should not be considered as being comprehensive since the scope of work contracted for is far less detailed than would be required for an in-depth evaluation of dams. Latent deficiencies, which might be detected by a totally comprehensive investigation, could exist.

A. Safety:

The embankment is generally in fair condition. Several items were noted during the visual inspection which should be corrected or controlled. These items are: (1) serious wave erosion on the front face of the embankment; (2) surface erosion on crest and downstream face in center portion of dam; (3) some trees and brush on downstream face; (4) standing water at toe of dam near center and in primary spillway channel; (5) seepage in one area on downstream face along west finger of embankment; (6) heavy grass and brush in primary spillway channel; and (7) protection of downstream toe from emergency spillway releases.

The dam will be overtopped by flows in excess of 60 percent of the Probable Maximum Flood. Overtopping of this earthen embankment could cause very rapid and disastrous erosion and could possibly lead to failure of the structure.

B. Adequacy of Information:

The conclusions in this report were based on review of the information listed in Section 2.1, the performance history as related by others, and visual observation of external conditions. The inspection team considers that these data are sufficient to support the conclusions herein. Seepage and stability analyses comparable to the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency.

C. Urgency:

The remedial measures recommended in paragraph 7.2 should be accomplished in the near future. If the deficiencies listed in paragraph A are not corrected, and if good maintenance is not provided, the embankment condition will

continue to deteriorate. Priority should be given to repairing and increasing the size of the spillways.

D. Necessity for Phase II:

Based on the result of the Phase I inspection, no Phase II inspection is recommended.

E. Seismic Stability:

The structure is located in seismic zone 1. An earthquake of this magnitude would not generally be expected to cause severe structural damage to a well constructed earth dam of this size. However, it is recommended that the prescribed seismic loading for this zone be applied in any stability analyses performed for this dam.

7.2 REMEDIAL MEASURES:

The following remedial measures and maintenance procedures are recommended. All remedial measures should be performed under the guidance of a professional engineer experienced in the design and construction of dams.

(1) Spillway size and/or height of dam should be increased to pass the PMF. In either case, the spillway should be protected to prevent erosion.

(2) Seepage and stability analyses comparable to the requirements of the recommended guidelines should be performed by an engineer experienced in the design and construction of dams.

(3) Brush and tree growth should be removed from the dam. This should be done under the guidance of a professional engineer experienced in the design and construction of dams. Indiscriminate clearing methods could jeopardize the safety of the dam.

(4) The erosional damage of the front face of the embankment should be corrected and maintained. Reshaping and placement of erosion protection will be necessary.

(5) The surface erosion on the crest and downstream face between Stas. 12+50 and 18+00 should be corrected and maintained.

(6) The seepage area on the downstream face near Sta. 18+

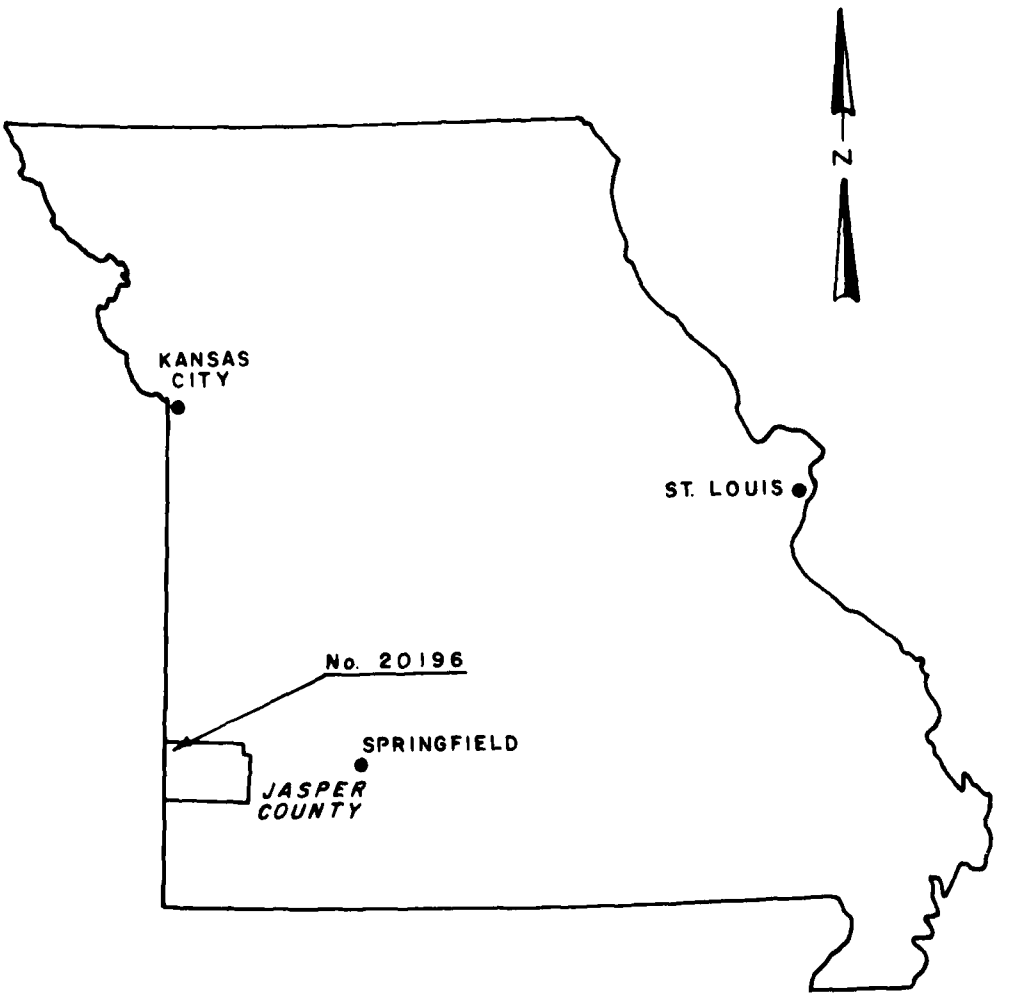
00, the area of standing water at the center toe of dam, and the primary spillway channel should be evaluated by an engineer experienced in the design of dams.

(7) The heavy grass and brush in the primary spillway channel should be mowed and cleared.

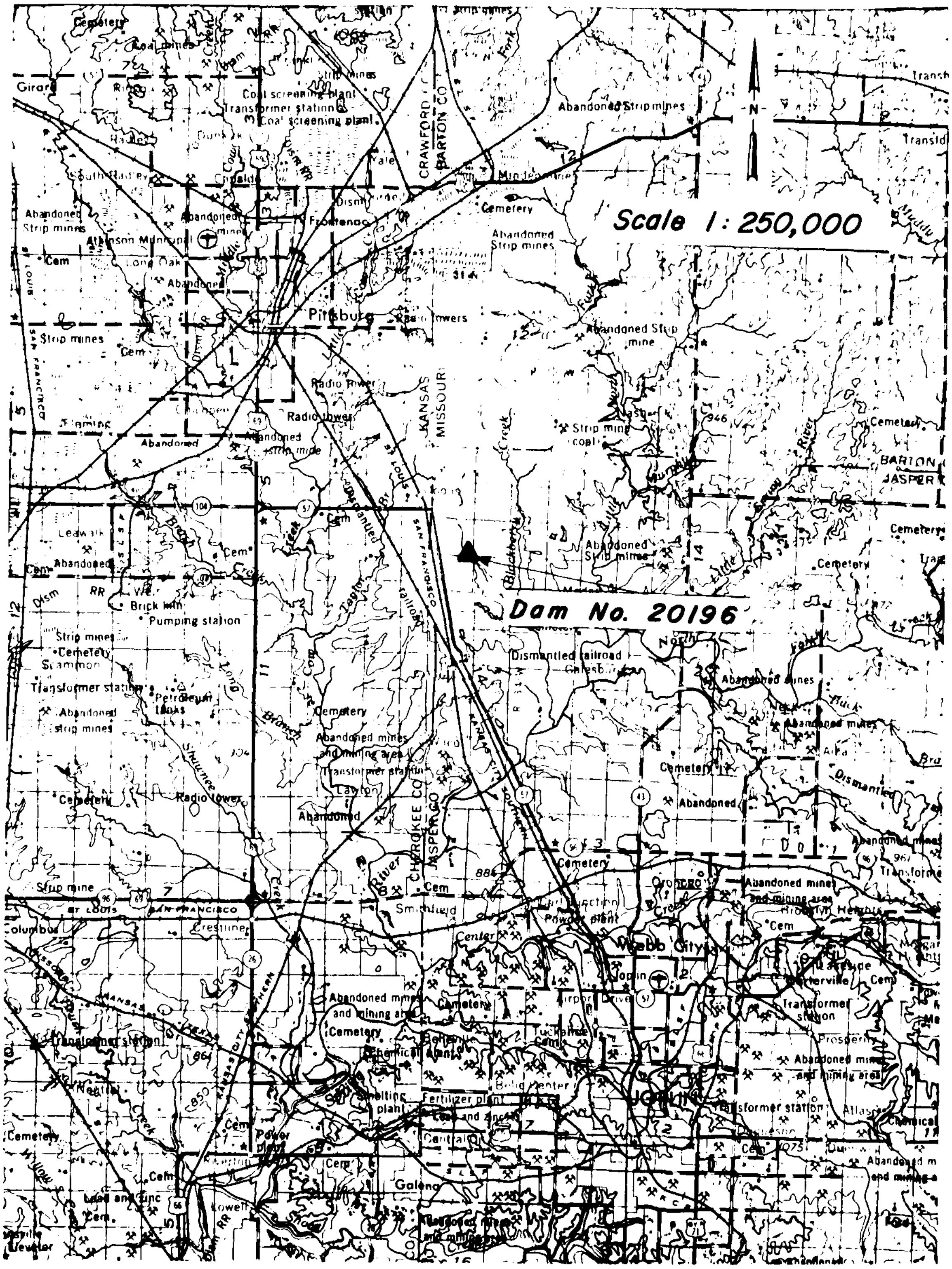
(8) It would appear adviseable to redirect the discharge channel of the emergency spillway away from the downstream toe of the dam.

(9) A detailed inspection of the dam should be made periodically by an engineer experienced in the design and construction of dams.

APPENDIX A

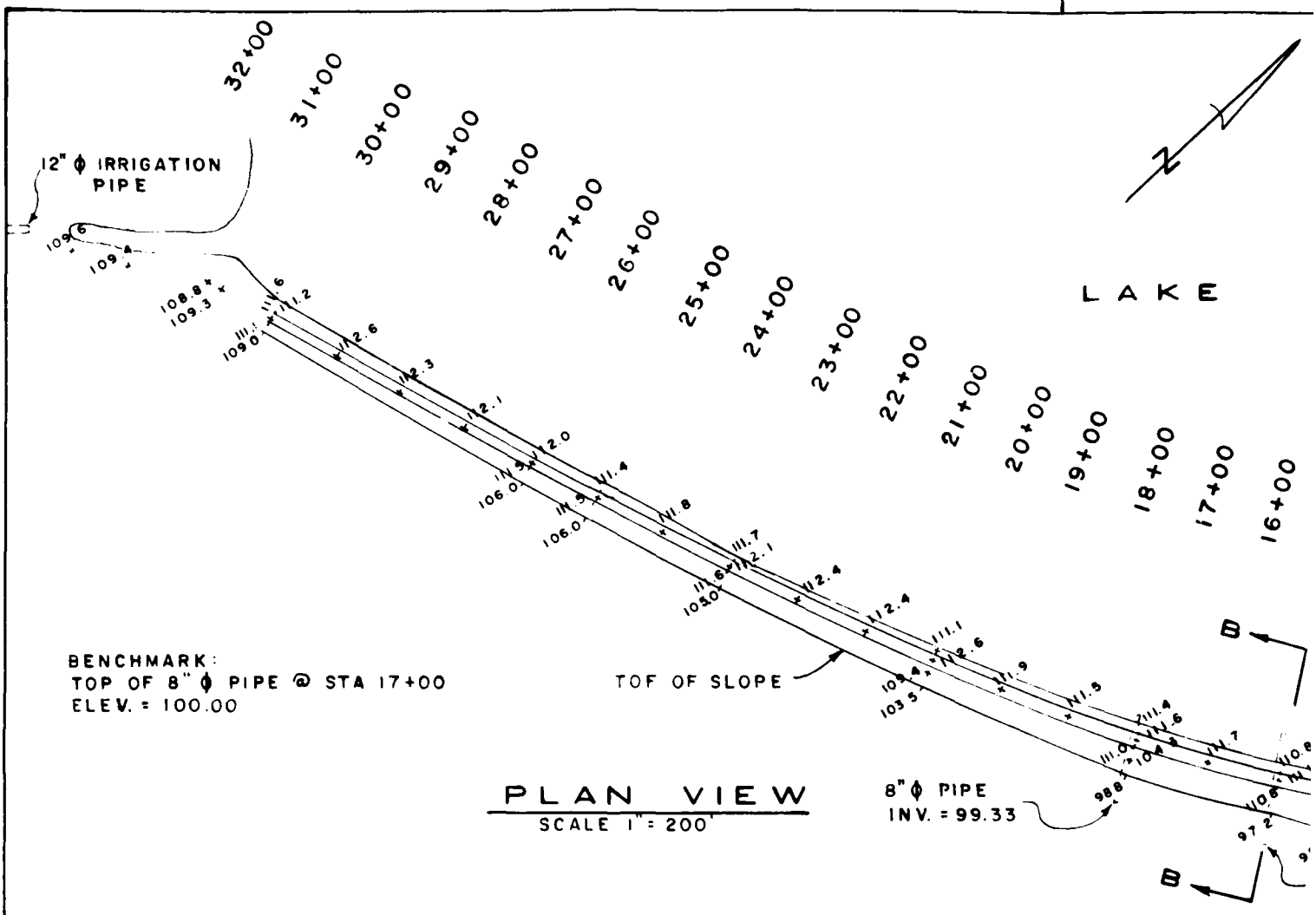


LOCATION MAP

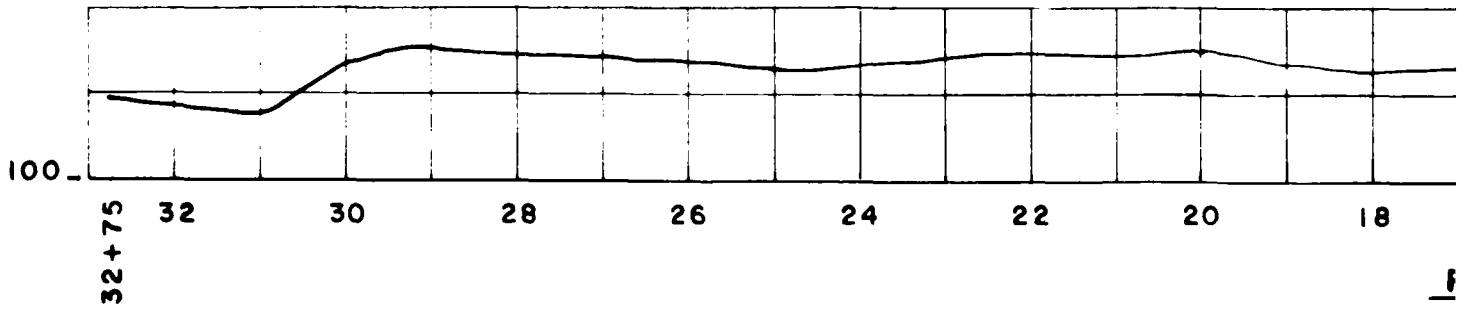


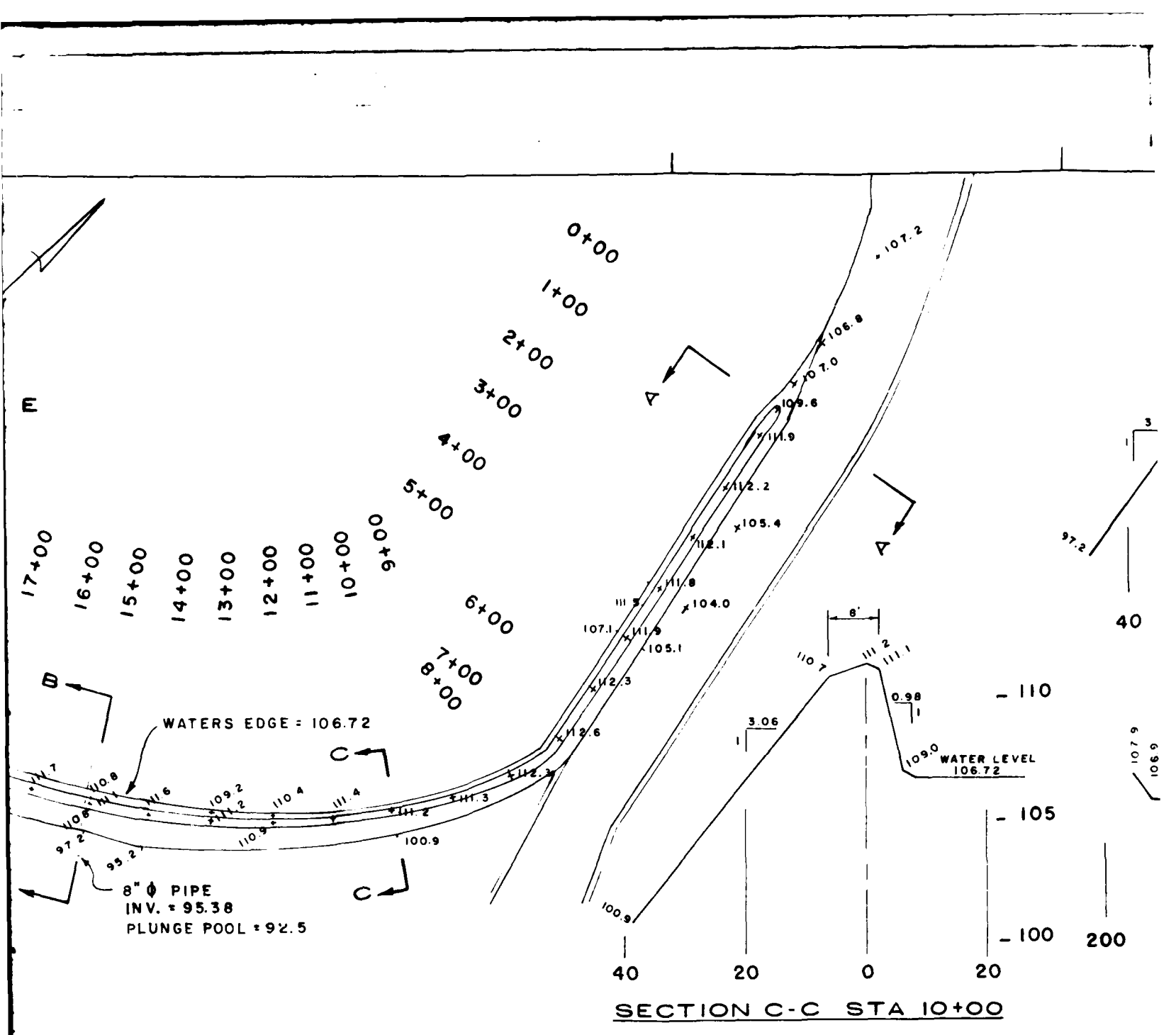
SITE VICINITY MAP

Sheet 2 Appendix A



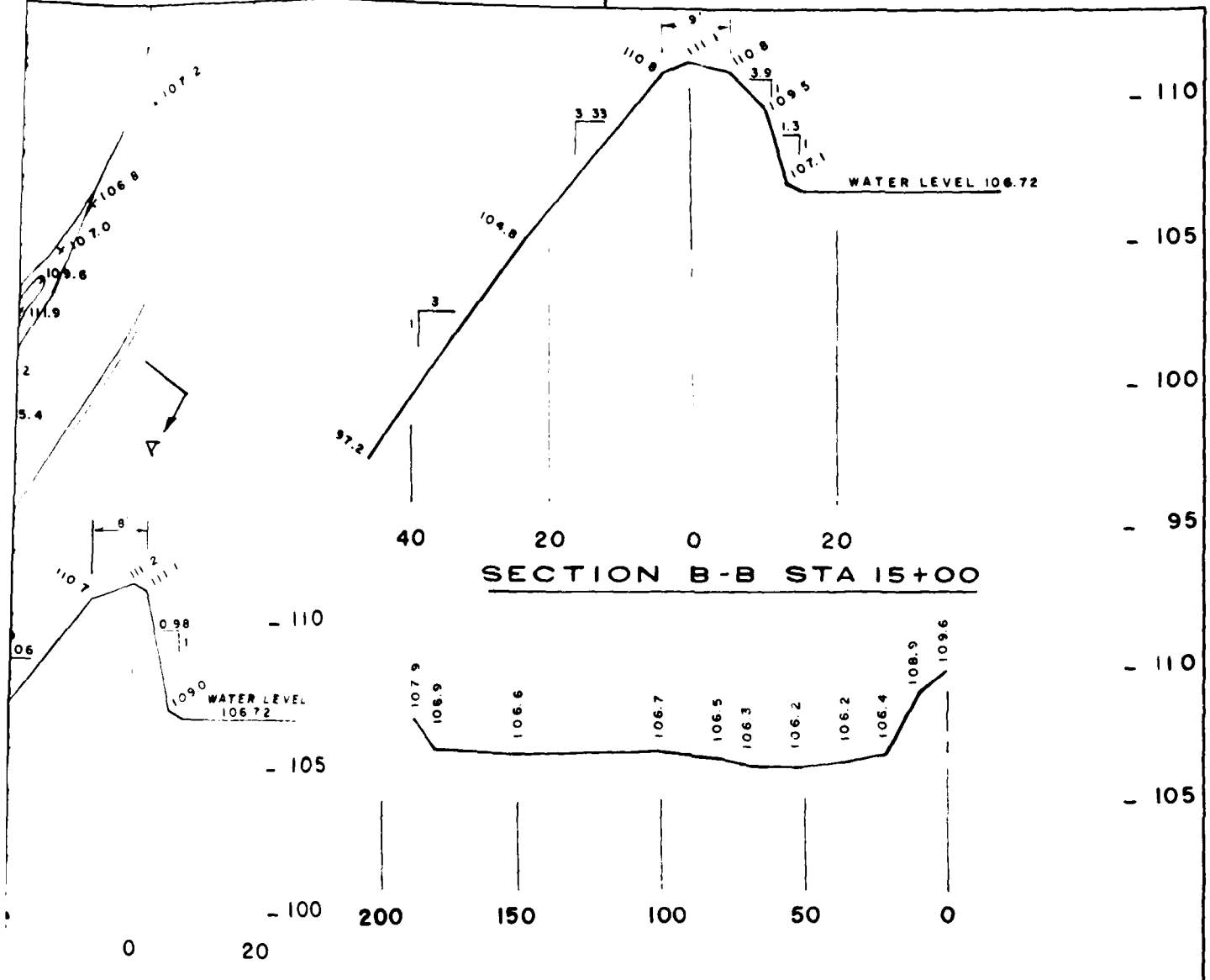
PLAN VIEW
SCALE 1" = 200'




0+00
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
10+00
11+00
12+00
13+00
14+00
15+00
16+00
17+00
E
A
A
B
C
C
WATERS EDGE = 106.72
8" ϕ PIPE
INV. = 95.38
PLUNGE POOL = 92.5
107.2
106.8
107.0
109.6
111.9
112.2
105.4
112.1
111.8
104.0
111.5
107.1
111.9
105.1
112.3
112.6
112.3
110.8
111.6
109.2
110.4
111.4
111.3
111.2
110.9
100.9
97.2
95.2
8'
110.7
111.2
111.1
0.98
3.06
109.0
WATER LEVEL
106.72
97.2
40
110
105
100
200
40
20
0
20
SECTION C-C STA 10+00
18
16
14
12
10
8
6
4
2
0
PROFILE

2

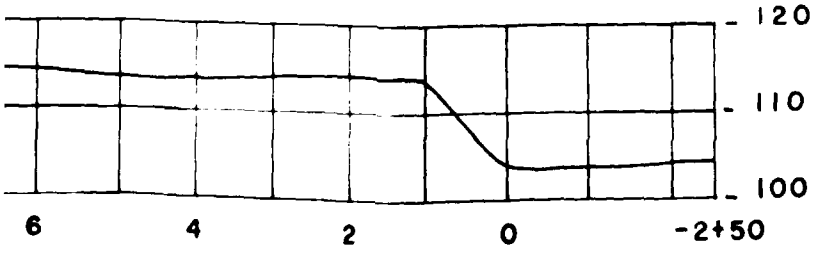
Sheet



SECTION B-B STA 15+00

SECTION A-A STA 0+50

C-C STA 10+00



ANDERSON ENGINEERING, INC.
700 NORTH BOSTON AVENUE
SPRINGFIELD, MISSOURI 65802

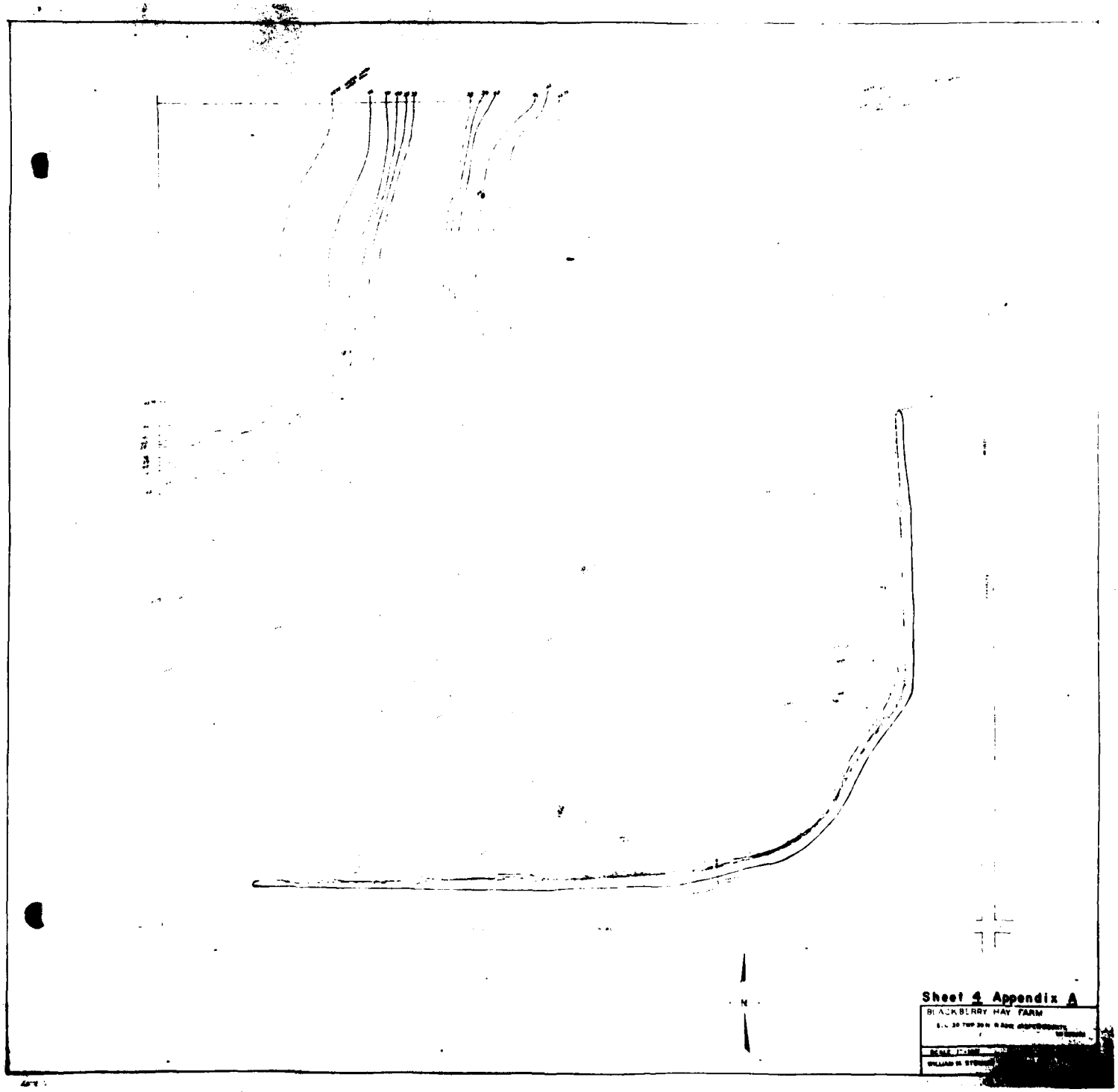
BLACKBERRY HAY FARM LAKE

MO No. 20196

PLAN & PROFILE

JASPER COUNTY, MO.

3

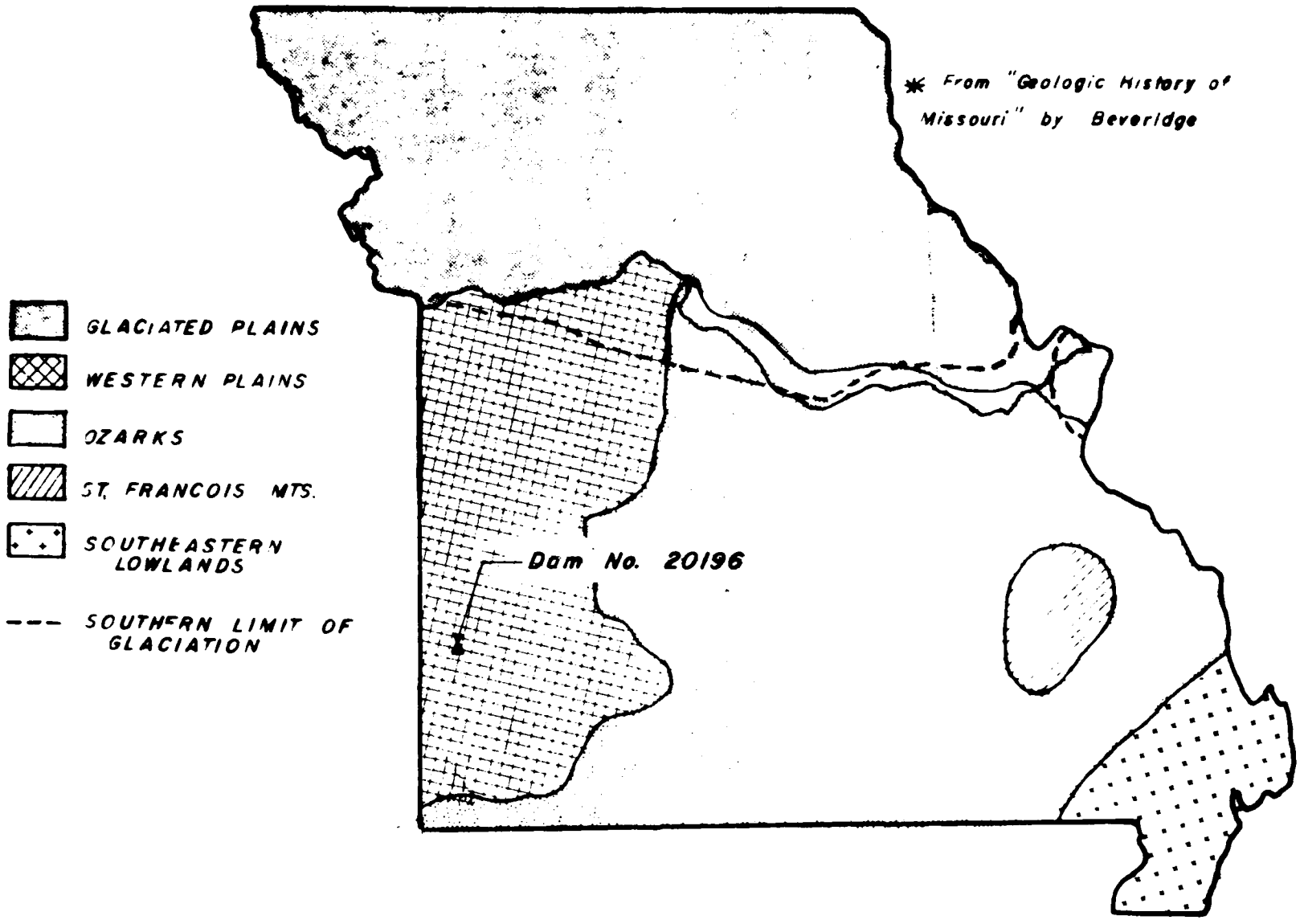


Sheet 4 Appendix A

BLACKBERRY HAY FARM

APPENDIX B

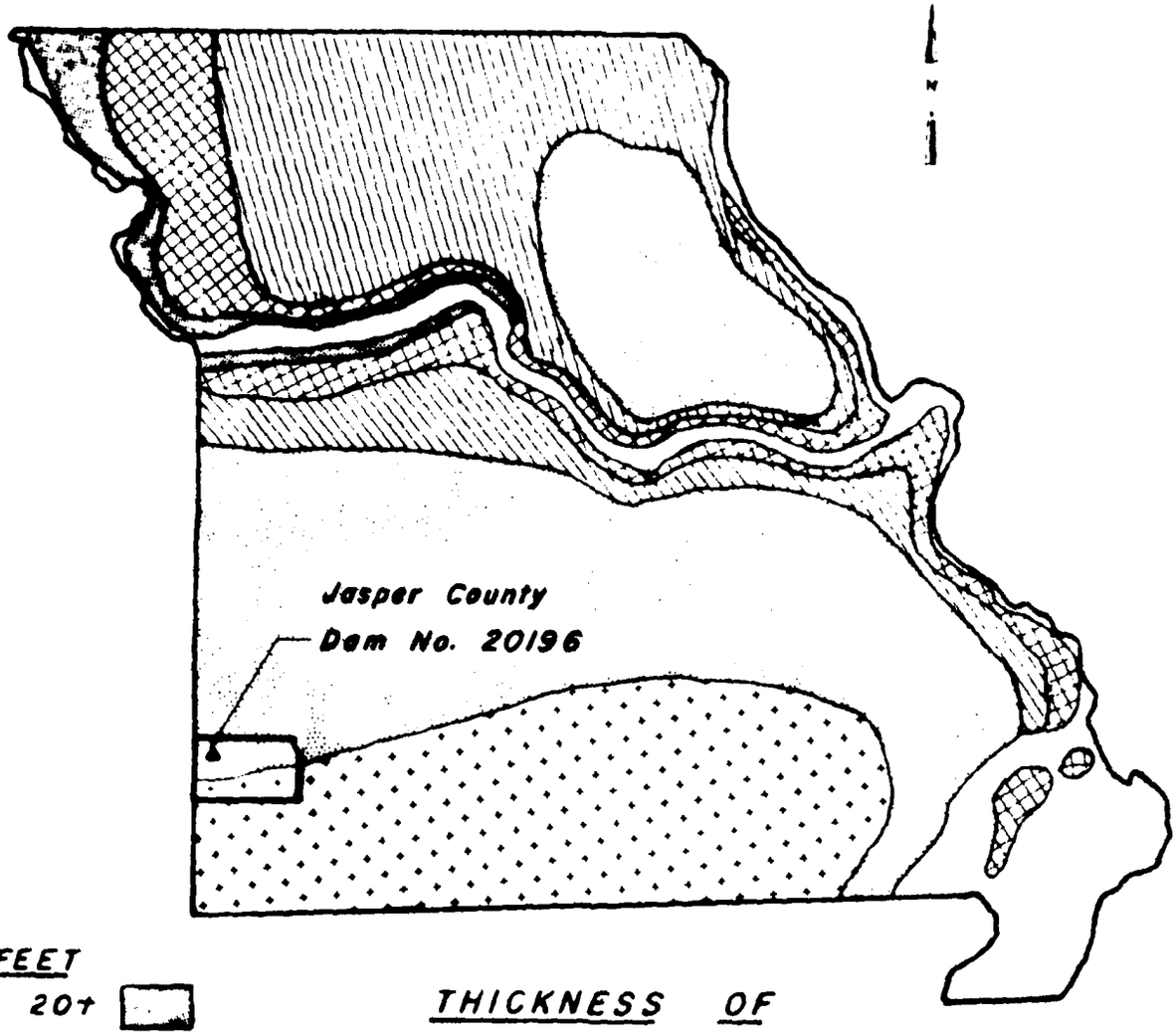
MAJOR GEOLOGIC REGIONS OF MISSOURI



* From "Geologic History of Missouri" by Beveridge

SHEET 1 OF APPENDIX B

* From "Soils of Missouri"



FEET

20+

10-20

5-10

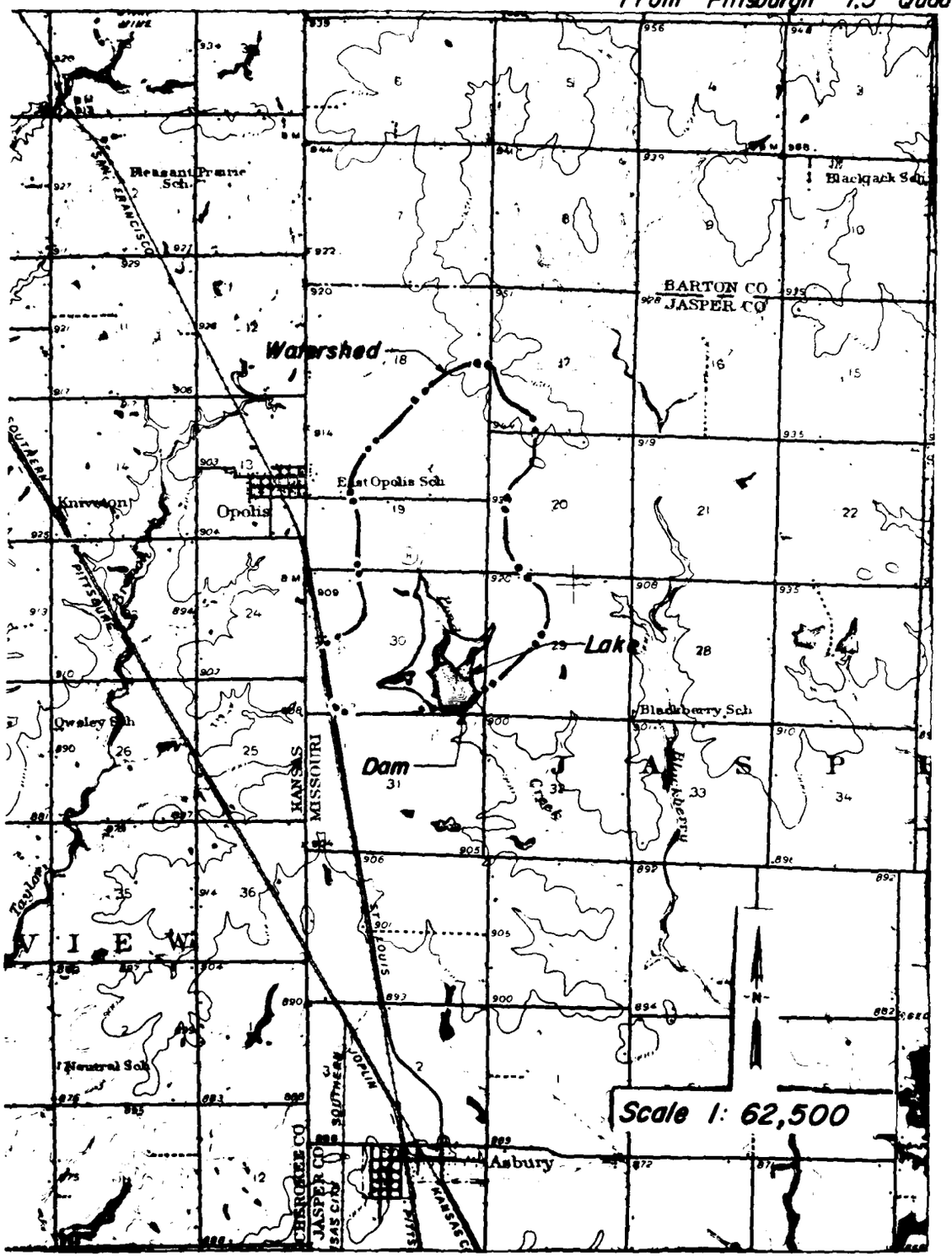
2.5-5

2.5-

THICKNESS OF LOESSIAL DEPOSITS

APPENDIX C

From Pittsburgh 7.5' Quad



LAKE AND WATERSHED MAP

Sheet 1 Appendix C

HYDRAULICS AND HYDROLOGIC DATA

Design Data: From Field Measurements and Computations

Experience Data: No records are available. Mr. Edward H. Landreth indicated that the dam has not been overtopped. Considerable erosion has taken place along the upstream slope of the dam due to wave action. The dam was enlarged in 1964.

Visual Inspection: At the time of inspection, the pool level was approximately 0.28 below normal pool.

Overtopping Potential: Flood routings were performed to determine the overtopping potential. The watershed and the reservoir surface areas were obtained by a planimeter-from the U.S.G.S. Pittsburg, Kansas-Missouri 15 minute quadrangle map. The storage volume was developed from this data. A 5 minute interval unit graph was developed for this watershed, which resulted in a peak inflow of 1752 c.f.s. and a time to peak of 45 minutes. Application of the probable maximum precipitation minus losses results in a flood hydrograph peak inflow of 17,285 c.f.s. Rainfall distribution for the 24 hour storm was according to EM 11102-1411.

Based on our analyses, the combined spillways will pass 60 percent of the Probable Maximum Flood (PMF). The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorologic and hydrologic conditions that are reasonably possible in the region. The recommended guidelines from the Department of the Army, Office of the Chief of Engineers, require that the structure (intermediate size with high downstream hazard potential) pass the PMF, without overtopping.

The routing of the PMF through the spillway and dam indicates that the dam will be overtopped by 0.80 ft. at elevation 112.30. The duration of the overtopping will be 1.92 hours, and the maximum outflow will be 16,374 c.f.s. The maximum discharge capacity of the combined spillways is 7235 c.f.s. Analysis of the data indicates that the 100-year frequency flood will not overtop the dam. The computer input, output and hydrographs for the PMF are presented on Sheets 5, 6 and 7 of Appendix C.

OVERTOPPING ANALYSIS FOR BLACKBERRY HAY FARM DAM

INPUT PARAMETERS

1. Unit Hydrograph - SCS Dimensionless - Flood Hydrograph Package (HEC-1); Dam Safety Version Was Used.
   Hydraulic Inputs Are as Follows:

   a. Twenty-four Hour Rainfall of 26.7 Inches for 200 Square Miles - All Season Envelope

   b. Drainage Area = 1680 Acres; = 2.63 Square Miles

   c. Travel Time of Runoff 1.13 Hrs.; Lag Time 0.68 Hrs.

   d. Soil Conservation Service Soil Group B

   e. Soil Conservation Service Runoff Curve No. 88 (AMC III)

   f. Proportion of Drainage Basin Impervious 0.10

2. Spillways

   a. Primary Spillway: Grass Covered Channel,

      Length: 140 Feet, C = 2.75

   b. Emergency Spillway: Grass Covered Channel,

      Length 35 ft.; Side Slopes Variable; C = 2.75

   c. Dam Overflow

      Length 2900 Ft.; Crest Elev. 111.5; C = 3.0

3. Spillway and Dam Rating:

   Curve Prepared by Hanson Engineers. Data Provided To Computer on Y4 and Y5 Cards.
   Equations used: Spillway $Q = CLH^{1.5}$

Note: Time of Concentration From Equation $Tc = \frac{(11.9\ L^3)^{.385}}{(H)^{.385}}$

California Culvert Practice, California Highways and Public Works, Sept. 1942.

SUMMARY OF DAM SAFETY ANALYSIS

1. Unit Hydrograph

   a. Peak - 1752 c.f.s.

   b. Time to Peak 45 Min.

2. Flood Routings Were Computed by the Modified Puls Method

   a. Peak Inflow

      50% PMF 8642 c.f.s.; 100% PMF 17,285 c.f.s.

   b. Peak Elevation

      50% PMF 111.19; 100% PMF 112.30

   c. Portion of PMF That Will Reach Top of Dam

      60%; Top of Dam Elev. 111.5 Ft.

3. Computer Input and Output Data are shown on Sheets 5 & 6 of this Appendix.

```
A       OVERTOPPING ANALYSIS FOR BLACK BERRY HAY FARM DAM ( DAM # 02 )
A       STATE ID NO. 20196  CO. NO. 097  CO. NAME JASPER
A       HANSON ENGINEERS INC. DAM SAFETY INSPECTION JOB # 79511
B    300                5
B1     5
J      1        7        1
J1   .15      .20      .30      .40      .50      .75      1.0
K      0        1                                  3        1
K1       INFLOW HYDROGRAPH COMPUTATION
M      1        2     2.63             2.63        1                          1
P      0     26.7      102      120      130
T                                                             -1      -88              0.10
U2  1.13     0.68
X      0     -.1        2
K      1        2                                  4        1
K1       RESERVOIR ROUTING BY MODIFIED PULS AT DAM SITE
Y                                  1        1
Y1     1                                                     640       -1
Y4   107    107.5      108      109      110      111    111.5      112
Y5     0      140      410     1260     2850     5513     7235     9094
$A     0      160      180      188
$E    95      107    111.5      113
$$   107
$D 111.5      3.0      1.5     2900
K     99
```

P.M.F. INPUT DATA

SHEET 5 APPENDIX C

********** ********** ********** ********** **********

PEAK FLOW AND STORAGE (END OF PERIOD) SUMMARY FOR MULTIPLE PLAN-RATIO ECONOMIC COMPUTATIONS
FLOWS IN CUBIC FEET PER SECOND (CUBIC METERS PER SECOND)
AREA IN SQUARE MILES (SQUARE KILOMETERS)

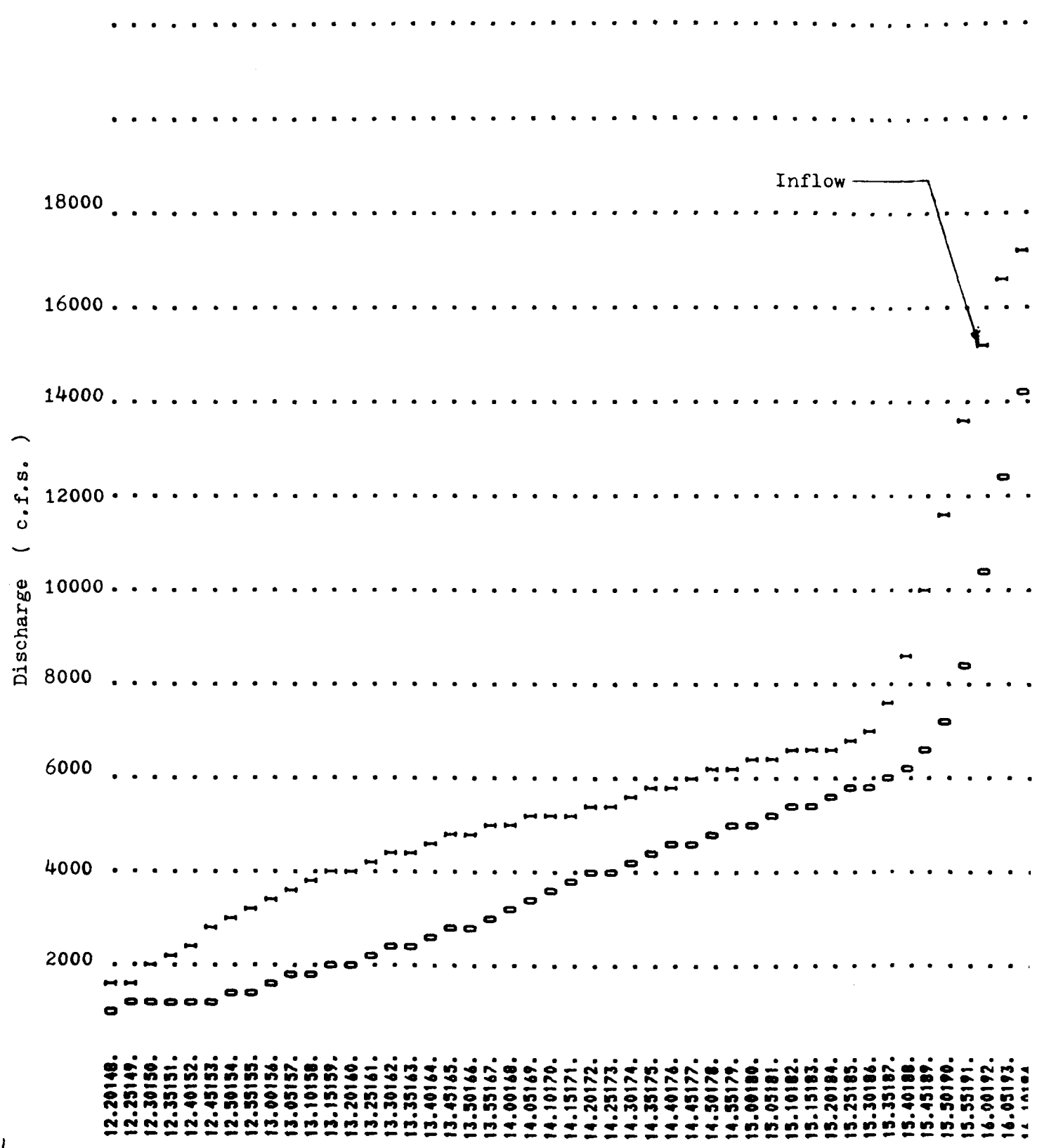
OPERATION	STATION	AREA	PLAN	RATIOS APPLIED TO FLOWS RATIO 1	RATIO 2	RATIO 3	RATIO 4	RATIO 5	RATIO 6	RATIO 7
				0.15	0.20	0.30	0.40	0.50	0.75	1.00
HYDROGRAPH AT	1	2.63	1	2593.	3457.	5185.	6914.	8642.	12964.	17285.
	(	6.81)	(	73.42)(	97.89)(	146.84)(	195.78)(	244.73)(	367.09)(	489.45)(
ROUTED TO	2	2.63	1	1196.	1832.	3142.	4666.	6153.	11460.	16374.
	(	6.81)	(	33.86)(	51.89)(	88.97)(	132.13)(	174.23)(	324.50)(	463.67)(

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	107.00	107.00	111.50
STORAGE	640.	640.	1405.
OUTFLOW	0.	0.	8185.

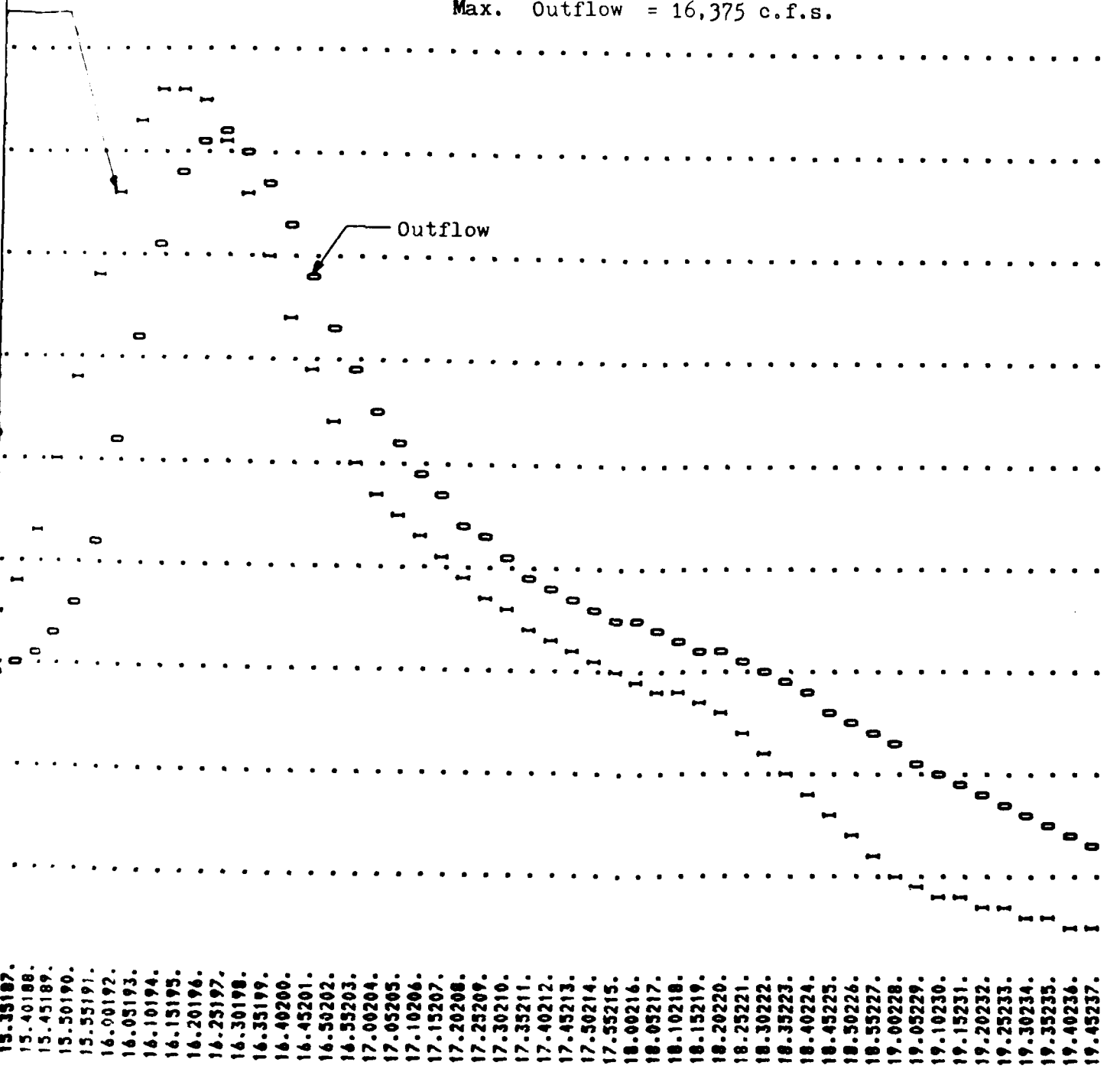
RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
0.15	108.92	0.00	956.	1196.	0.00	17.25	0.00
0.20	109.36	0.00	1030.	1832.	0.00	17.08	0.00
0.30	110.11	0.00	1159.	3142.	0.00	16.83	0.00
0.40	110.68	0.00	1259.	4666.	0.00	16.75	0.00
0.50	111.19	0.00	1348.	6153.	0.00	16.67	0.00
0.75	111.94	0.44	1485.	11460.	1.17	16.50	0.00
1.00	112.30	0.80	1550.	16374.	1.92	16.42	0.00


Inflow
18000
16000
14000
12000
10000
8000
6000
4000
2000
Discharge (c.f.s.)
Time (

INFLOW - OUTFLOW
HYDROGRAPH
FOR 100% P. M. F.

Max. Inflow = 17,285 c.f.s.

Max. Outflow = 16,375 c.f.s.



15.35187.
15.40188.
15.45189.
15.50190.
15.55191.
16.00192.
16.05193.
16.10194.
16.15195.
16.20196.
16.25197.
16.30198.
16.35199.
16.40200.
16.45201.
16.50202.
16.55203.
17.00204.
17.05205.
17.10206.
17.15207.
17.20208.
17.25209.
17.30210.
17.35211.
17.40212.
17.45213.
17.50214.
17.55215.
18.00216.
18.05217.
18.10218.
18.15219.
18.20220.
18.25221.
18.30222.
18.35223.
18.40224.
18.45225.
18.50226.
18.55227.
19.00228.
19.05229.
19.10230.
19.15231.
19.20232.
19.25233.
19.30234.
19.35235.
19.40236.
19.45237.

Time (hrs.)

APPENDIX D

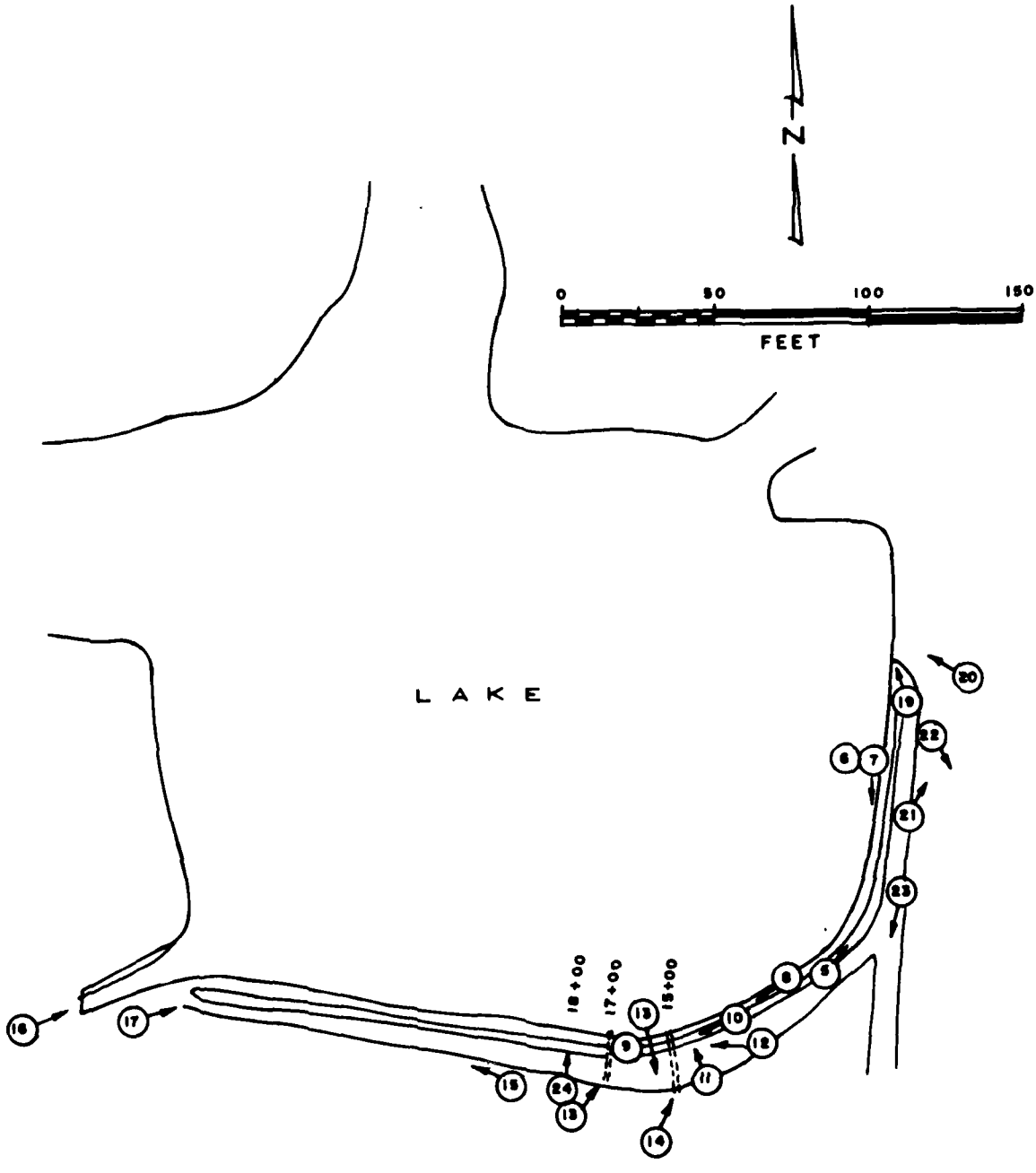
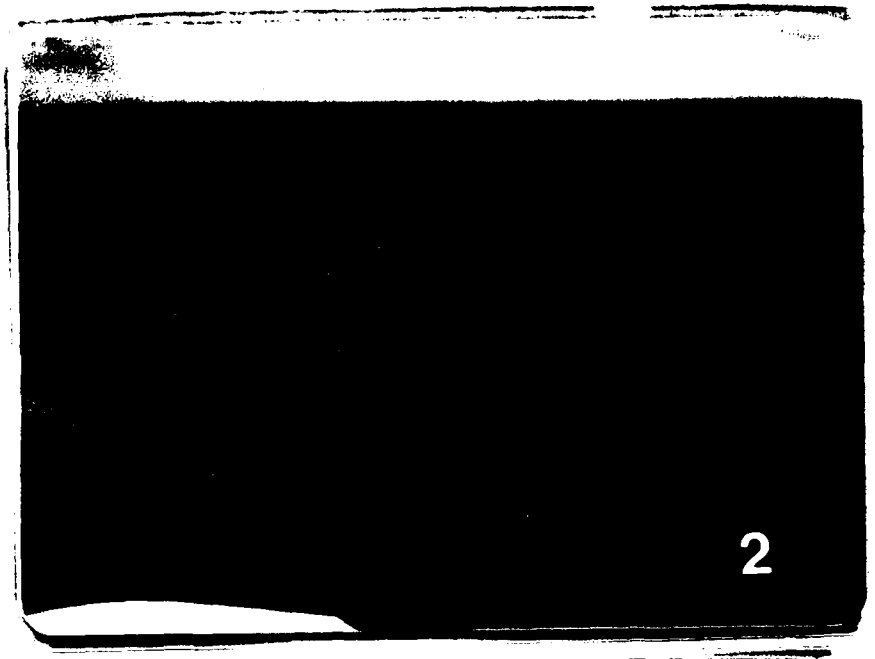


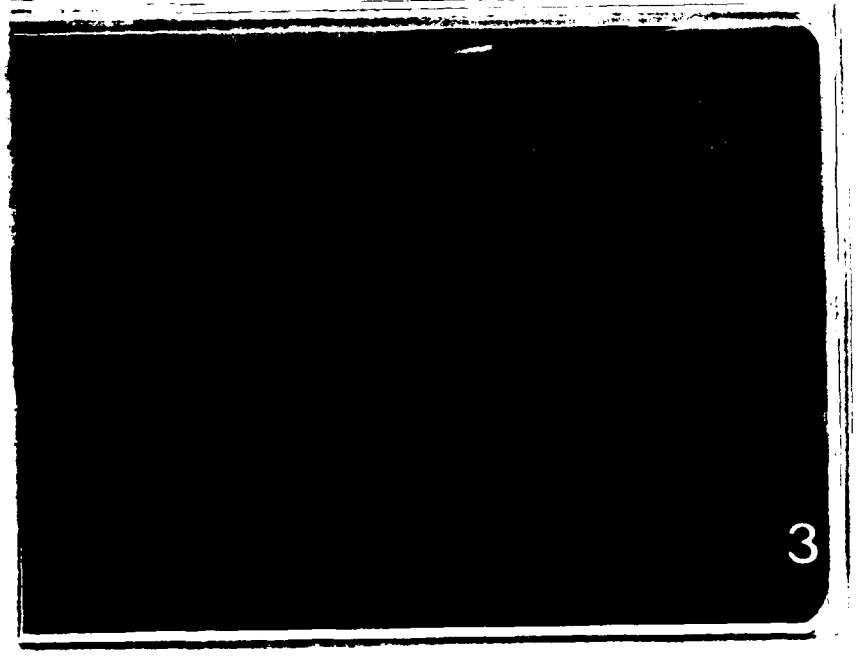
PHOTO INDEX
BLACKBERRY HAY FARM
JASPER COUNTY, MO.

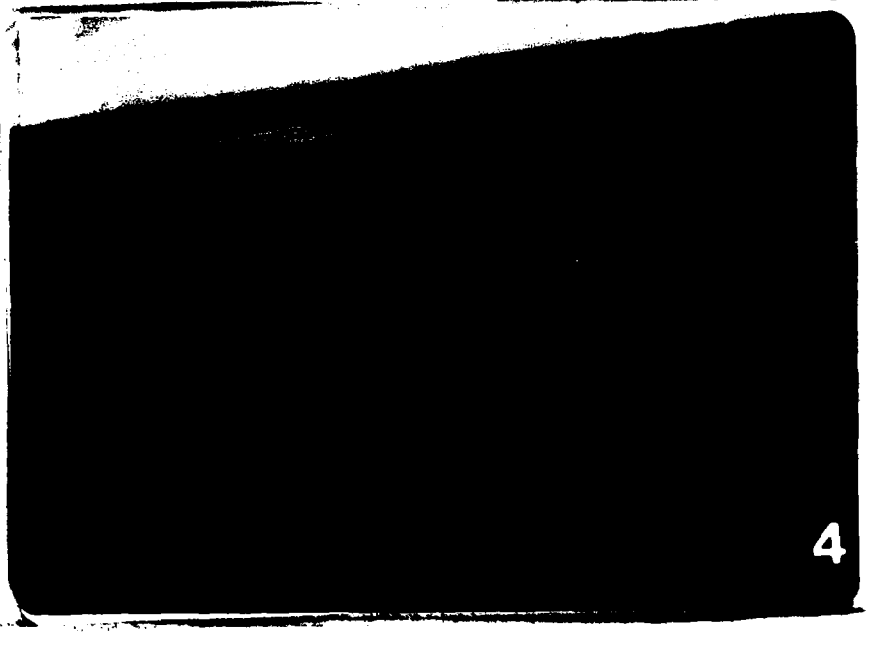
Sheet 1 of Appendix D

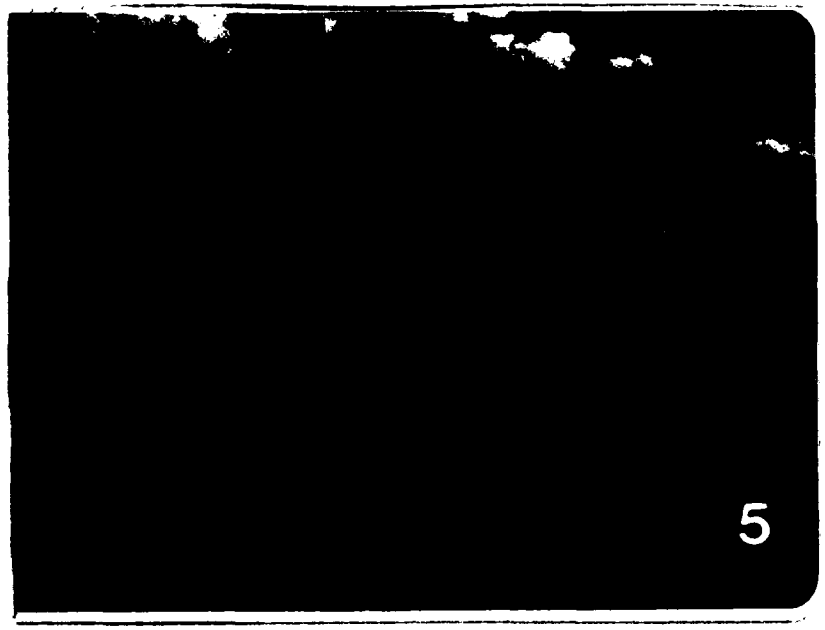
LIST OF PHOTOGRAPHS

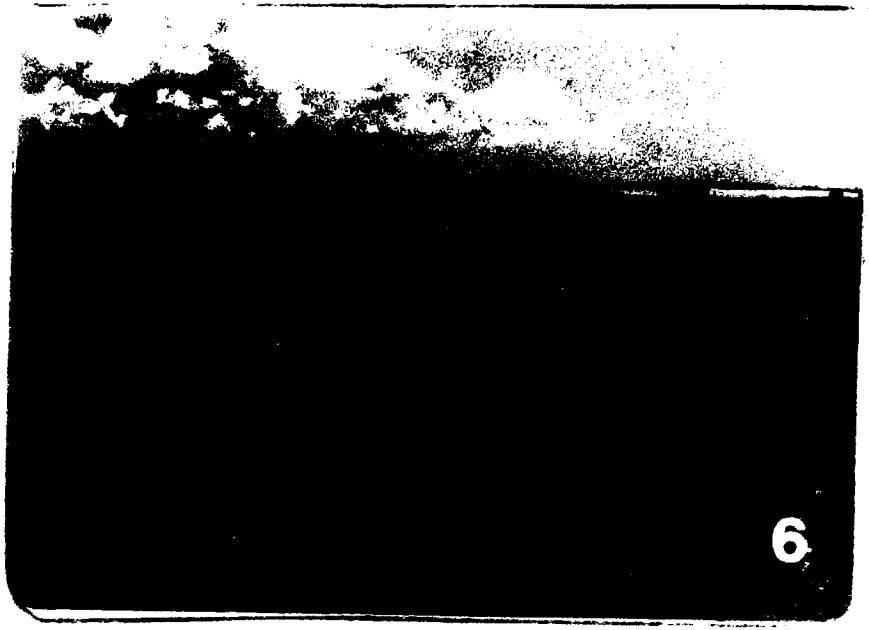
Photo No.	
1.	Aerial Photo Looking North
2.	Aerial Photo Looking Southeast
3.	Aerial Photo Looking Northwest
4.	Aerial Photo Looking Northeast
5.	Crest of Dam, South Side
6.	Front Face of Dam
7.	Front Face of Dam, Note Erosion
8.	Crest of Dam, South Side
9.	Crest of Dam, Note Surface Cracks
10.	Crest of Dam, South Side, Note Erosion
11.	Downstream Face Showing Erosion
12.	Downstream Face Showing Erosion
13.	West Drawdown Pipe Outlet
14.	East Drawdown Pipe Outlet
15.	Downstream Face, South Side
16.	Irrigation Channel at West End of Embankment
17.	West End of Embankment
18.	Downstream Channel
19.	Primary Spillway at North End
20.	Primary Spillway Entrance
21.	Primary Spillway Channel
22.	Primary Spillway Channel
23.	Primary Spillway Embankment
24.	Seepage Area Near Sta. 18+00



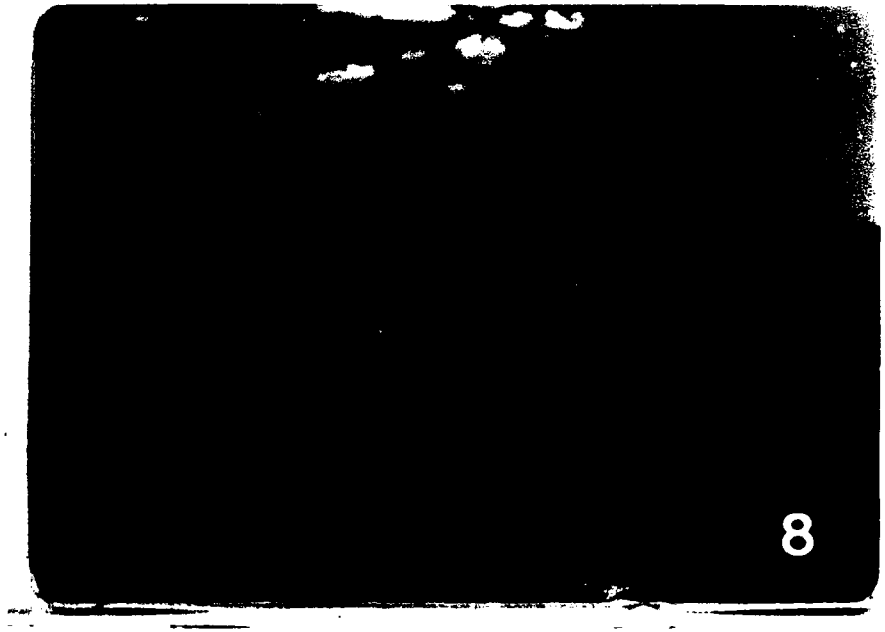





5


6

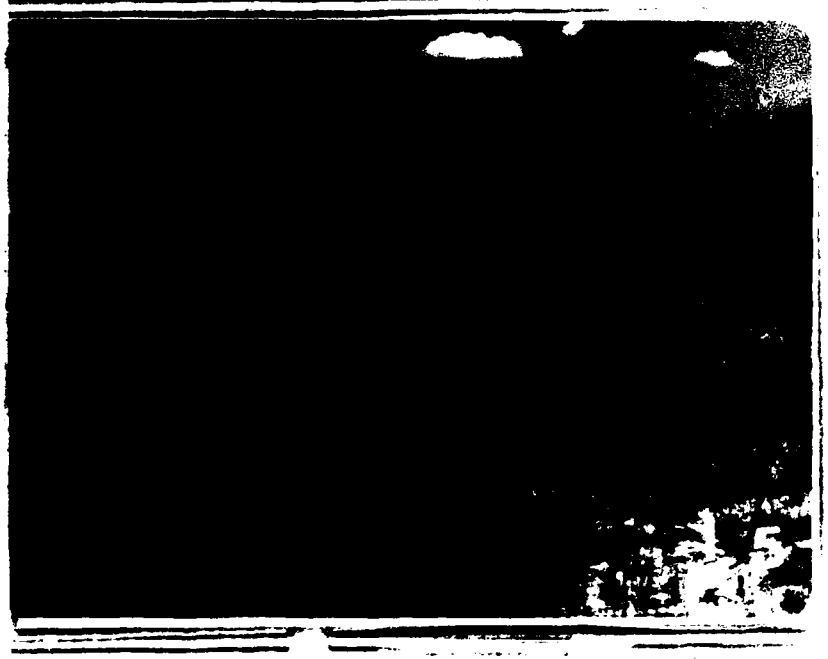

7

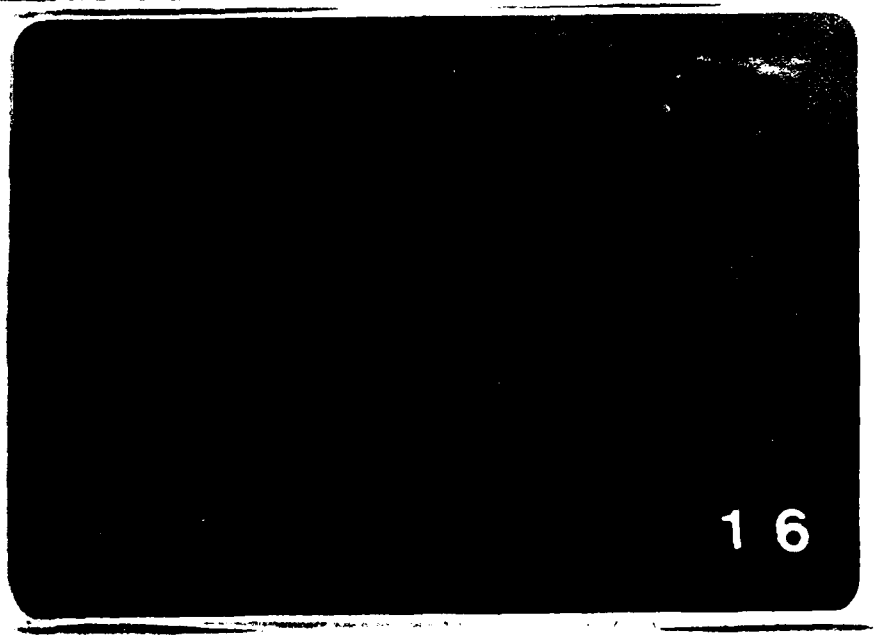

8

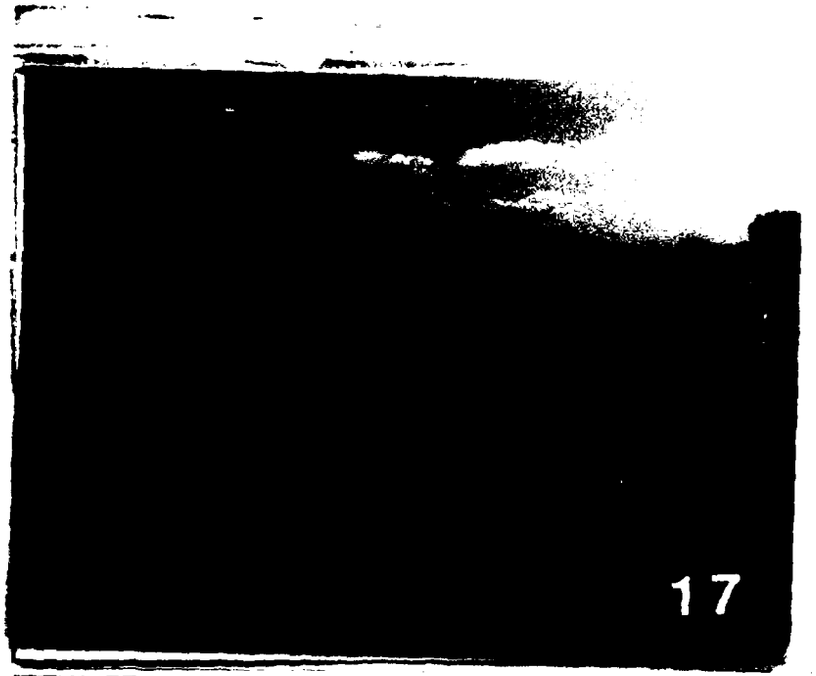

9


11

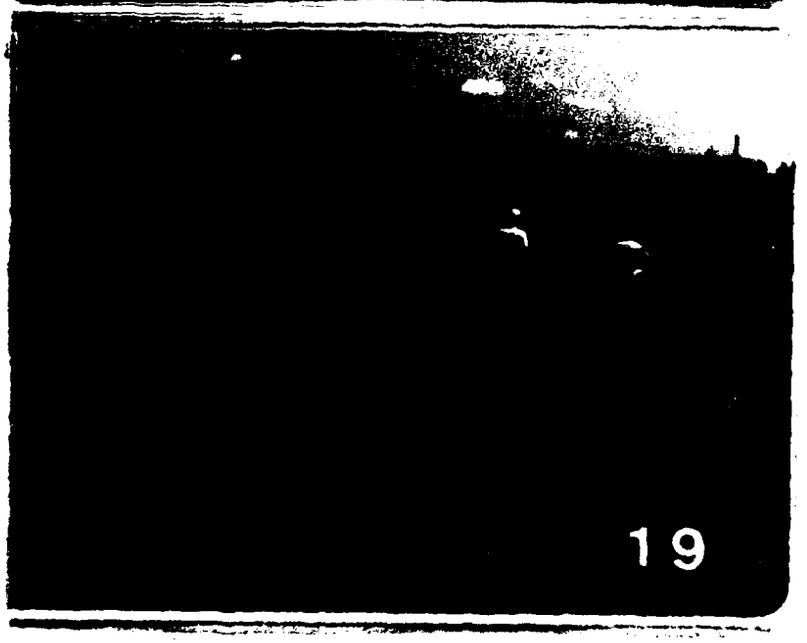

12

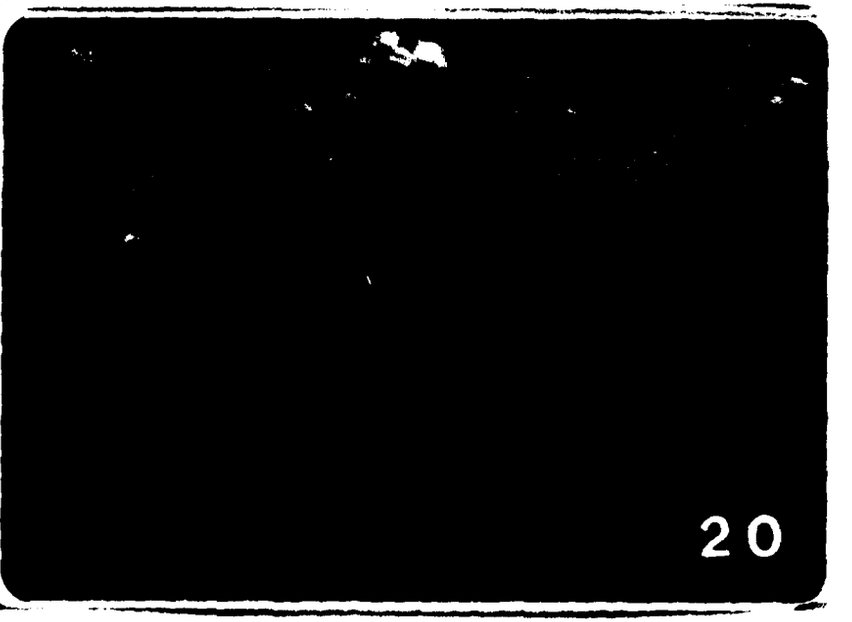


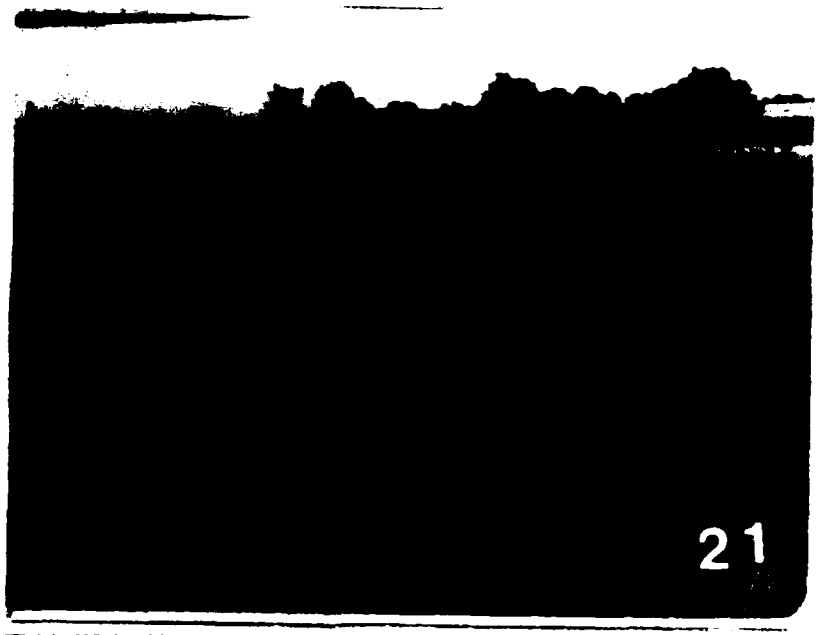

16


17


8

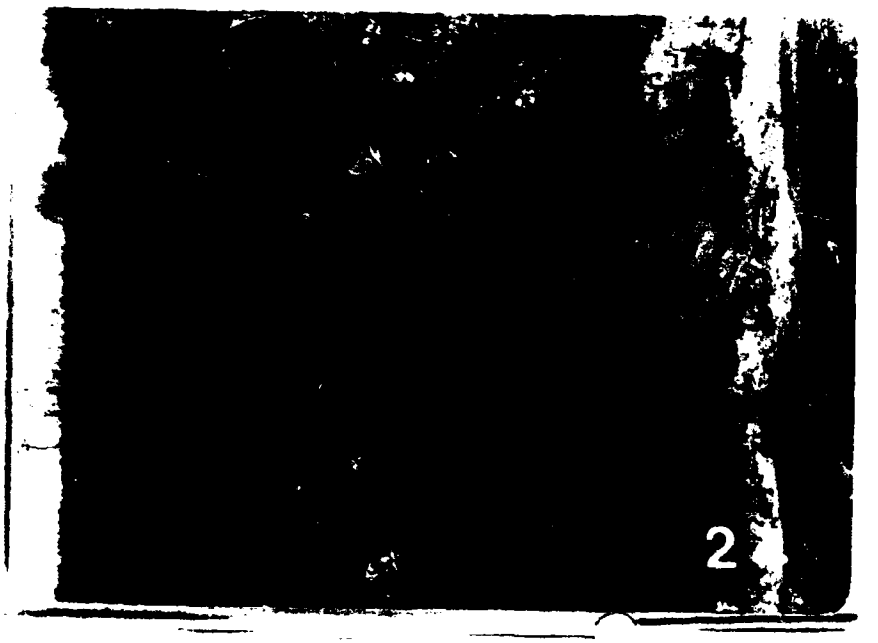

19


20


21


2 2


2 3


2


DATE
FILME
0-8